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Atlas of Cloud-Free Line-of-Sight Probabilities Part 5: North Africa and the Middle East

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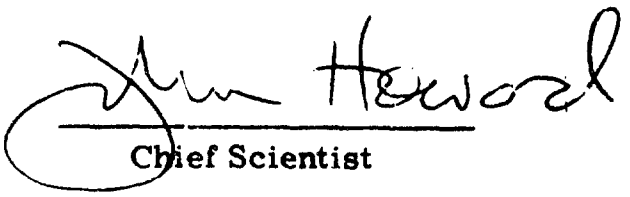

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This is the fifth part of a planned Northern Hemisphere atlas of probabilities of cloud-free lines-of-sight between the earth and space. The probabilities are for the mid-season months: January, April, July, and October; four times of day: 0000-0200 LST, 0600-0800 LST, 1200-1400 LST, and 1800-2000 LST, and three elevation angles: 10°, 30°, and 90°. Parts 1, 2, 3, and 4 depicted cloud-free line-of-sight probabilities for Germany, the USSR, the USA, and Europe, respectively.

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Contents

Illustrations

Illustrations

Illustrations

Tables

Atlas of Cloud-Free Line-of-Sight Probabilities
Part 5: North Africa and the Middle East

1. INTRODUCTION

The increased use of optical, infrared, and microwave observing and transmitting devices has resulted in a greater demand for information on humidity, haze, clouds, and precipitation. The Air Force Geophysics Laboratory (AFGL)* Climatology and Dynamics Branch (LYD), Hanscom AFB, MA 01731, and the USAF Environmental Technical Applications Center (ETAC)*, Scott AFB, IL 62225, have responded to this demand by collecting special observations, developing models for estimating the desired information in the absence of direct observations, and processing vast quantities of data.

One of the items frequently requested is information on the probability of a cloud-free line-of-sight (CFLOS) between a specific point on the surface of the earth and an aircraft or an object in space. In response to these requests, AFGL and ETAC are endeavoring to prepare a Northern Hemisphere atlas of CFLOS probabilities. Because this is a very time-consuming effort, we have decided to prepare the atlas in parts, as data become available. The first, second, third,

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*Department of Defense organizations and contractors are encouraged to contact AFGL or ETAC for additional information on line-of-sight probabilities. Persistence, recurrence, joint probabilities, and probabilities as a function of altitude are available.

and fourth parts depicting CFLOS probabilities over Germany,[1] the USSR,[2] the USA,[3] and Europe[4] have been published.

2. THE MODEL

Lund and Shanklin[5] developed models for estimating probabilities of CFLOS through the atmosphere at any desired elevation angle and geographical location. The models require a knowledge of sky-cover climatology for the locations.

The model used to estimate CFLOS probabilities through the entire atmosphere can be expressed as follows:

$$ {}_{\alpha}\hat{P}_1 = {}_{\alpha}C_s K_1 \qquad (1) $$

where ${}_{\alpha}\hat{P}_1$ is a column vector of α rows, one row for each angle considered; ${}_{\alpha}C_s$ is a matrix of α rows and s columns, one column for each sky cover category; and ${}_{s}K_1$ is a column vector of s rows. The $\hat{P}$ values are estimates of CFLOS probabilities, the C values are CFLOS probabilities at angle α given k tenths of cloudiness, and the K values are climatic probabilities of each k tenths of cloudiness for the location of interest.

1. Lund, I. A., Grantham, D. D., and Elam, C. B., Jr. (1975) Atlas of Cloud-Free Line-of-Sight Probabilities, Part 1: Germany, AF Surveys in Geophysics No. 309, AFCRL-TR-75-0261, 77 pp.

2. Lund, I. A., Grantham, D. D., and Elam, C. B., Jr. (1976) Atlas of Cloud-Free Line-of-Sight Probabilities, Part 2: Union of Soviet Socialist Republics, AF Surveys in Geophysics No. 358, AFGL-TR-77-0005, 63 pp.

3. Lund, I. A., Grantham, D. D., and Elam, C. B., Jr. (1977) Atlas of Cloud-Free Line-of-Sight Probabilities, Part 3: United States of America, AF Surveys in Geophysics No. 374, AFGL-TR-77-0188, 73 pp.

4. Lund, I. A., Grantham, D. D., and Elam, C. B., Jr. (1978) Atlas of Cloud-Free Line-of-Sight Probabilities, Part 4: Europe, AF Surveys in Geophysics No. 400, AFGL-TR-78-0276, 71 pp.

5. Lund, I. A., and Shanklin, M. D. (1973) Universal methods for estimating probabilities of cloud-free lines-of-sight through the atmosphere, J. Appl. Meteorol. 12 (No. 1):28-35.

The $_{\alpha}C_{s}$ matrix used for this paper is given in Table 1.

Table 1. Probabilities of Cloud-Free Lines-of-Sight as a Function of Elevation Angle and Observed Total Sky Cover, in Octas. This is the $_{\alpha}C_{s}$ Matrix

Elevation Angle (Degrees)	Sky Cover (Octas)								
	0	1	2	3	4	5	6	7	8
90	1.00	0.96	0.89	0.83	0.77	0.68	0.55	0.35	0.08
30	0.98	0.92	0.83	0.75	0.66	0.55	0.43	0.28	0.06
10	0.97	0.84	0.72	0.58	0.47	0.38	0.28	0.17	0.03

3. AN EXAMPLE

The climatic record of sky cover at Cairo, United Arab Republic shows that 0/8, 1/8, ..., 7/8 and 8/8 sky cover was reported 15.9, 5.3, 9.6, 9.3, 7.3, 14.6, 14.6, 18.2 and 5.3 percent of the time, respectively, between 1200-1400 LST during January 1957 through December 1966. Performing the matrix multiplication, we obtain:

$$ {}_{\alpha}\hat{p}_{1} = \begin{bmatrix} 1.00 & 0.97 & \cdots & 0.31 & 0.08 \\ 0.98 & 0.93 & \cdots & 0.24 & 0.06 \\ 0.97 & 0.86 & \cdots & 0.16 & 0.03 \end{bmatrix} \begin{bmatrix} 0.159 \\ 0.053 \\ . \\ . \\ 0.182 \\ 0.053 \end{bmatrix} = \begin{bmatrix} 0.676 \\ 0.599 \\ 0.485 \end{bmatrix} \qquad (2) $$

The computations show that there is a 67.6 percent probability of a CFLOS at Cairo looking toward the zenith (90°), and a 59.9 percent and 48.5 percent probability of a CFLOS at 30° and 10° elevation angles, respectively.

4. THE STATIONS

Table 2 lists stations from which records of hourly sky-cover observations are available. The last two columns in the table give the number of observations for the month and the hour with the fewest observations (min), and the number of observations for the month and hour with the most observations (max). All of the CFLOS probabilities were based on at least 50 observations, and some were based

on more than 1000 observations. Users of the atlas should understand that probabilities based on less than about 200 sky-cover observations may not be a reliable estimate of the long-term climatic value. CFLOS probabilities were computed for the stations shown in Figure 1.

5. THE ANALYSIS

A total of 51 maps are included in this report: one station locator map, Figure 1; one map for each of the four mid-season months (January, April, July, October) covering four 3-hr periods (0000-0200 LST, 0600-0800 LST, 1200-1400 LST, 1800-2000 LST), and three elevation angles (10°, 30°, 90°), Figures 2 through 49; and two maps depicting the extreme conditions; that is, the highest and the lowest probability for any of the above months and periods, Figures 50 and 51. In order to conserve space, the extreme condition is shown for the 30° elevation angle only.

Eq. (1) was used to compute CFLOS probability values. The ${}_{s}K_{1}$ column vector was changed with every station, month, or 3-hr time period. The probability values were plotted on maps and analyzed as shown in Figures 2 through 51.

Because the isolines are drawn strictly to the data, the analysis seldom departs more than 2 or 3 percent from the computed probabilities. The analysis is based solely on probabilities at the locations shown by dots on the maps. Probabilities were not computed and station location dots are not shown for hours and months when less than 50 observations were available for determining the CFLOS probabilities. No attempt was made to adjust the analysis between data points for the influence on cloudiness of terrain, water bodies, the general wind circulation, and the like. The atlas is intended to provide a large-scale picture of the geographical distribution of CFLOS probabilities. The data coverage is too sparse to perform an accurate, detailed analysis. Probability values are plotted on the maps but no analysis was performed over the Canary Islands and some isolated points where the pattern was very uncertain. If the location of interest is not a station used in the analysis, the user of this atlas may wish to consult other data sources for additional cloud-cover data and compute CFLOS probabilities for the specific location of interest using Eq. (1).

The CFLOS atlas for Germany, Part 1 of this series, included probabilities for the 50° elevation angle. They are not included in this report because more than 97 percent of the time they ranged from 1 to 2.5 percent less than corresponding probabilities for the 90° elevation angle. The 50° elevation angle probabilities were always at least 1 percent less than the 90° probabilities, but never more than 3.5 percent less. Probabilities for the 50° elevation angle should be estimated by subtracting 2 percent from the 90° probabilities.

Table 2. Station Locator

Map Number	Station Name	WMO Number	Lat.	Long.	Altitude (m)	Number of Observations Min.	Max.
	Turkey						
1	Edirne	17050	41°40' N	26°34' E	48	354	432
2	Ankara	17129	39°57' N	32°41' E	799	353	420
3	Samsun	17030	41°17' N	36°20' E	44	262	291
4	Izmir/Gigli AB	17218	38°31' N	27°01' E	5	1005	1302
5	Mugla	17292	37°12' N	28°21' E	646	218	276
6	Konya	17244	37°59' N	32°34' E	1032	299	430
7	Adana/Incirlik AB	17350	37°00' N	35°26' E	73	1022	1116
8	Erzincan	17092	39°43' N	39°31' E	1156	361	413
9	Van	17170	38°28' N	43°20' E	1667	256	282
10	Akrotiri	17601	34°35' N	32°59' E	23	307	368
	Syria						
11	Alepo	40007	36°11' N	37°14' E	389	329	409
12	Qamichliye	40001	37°02' N	41°12' E	452	296	406
13	Palmyra	40061	34°33' N	38°19' E	401	105	249
14	Damascus	40079	33°29' N	36°14' E	729	190	238
	Lebanon						
15	Beirut/Intl	40100	33°49' N	35°29' E	26	158	338
	Israel						
16	Lod Airport	40180	32°00' N	34°54' E	40	426	461
17	Jerusalem	40184	31°47' N	35°13' E	809	516	589
18	Eilat	40199	29°34' N	34°58' E	13	348	612
	Jordan						
19	Amman Jordan	40270	31°58' N	35°59' E	775	237	359
20	H 4 Jordan	40250	32°30' N	38°12' E	686	62	206
	Iran						
21	Tabriz	40706	38°08' N	46°15' E	1366	195	303
22	Tehran-Mehrabad	40754	35°41' N	51°19' E	1204	121	216
23	Mashhad	40745	36°14' N	59°39' E	989	58	180
24	Esfahan	40800	32°37' N	51°42' E	1597	194	321
25	Abadan	40831	30°22' N	48°14' E	3	185	304
26	Bushehr	40846	28°57' N	50°50' E	4	53	217
	Afghanistan						
27	Kabul	40948	34°34' N	69°12' E	1789	52	193
	Pakistan						
28	Fort Sandeman	41620	31°21' N	69°27' E	1405	86	405
29	Dalbandin	41712	28°53' N	64°24' E	848	130	413
30	Jocobabad	41715	28°18' N	68°27' E	55	75	402
31	Karachi Apt	41780	24°54' N	67°09' E	30	148	245

Table 2. Station Locator (continued)

Map Number	Station Name	WMO Number	Lat.	Long.	Altitude (m)	Number of Observations Min.	Max.
	Kuwait						
32	Kuwait Intl Apt	40372	29°14' N	47°59' E	56	52	128
	Bahrain						
33	Muharraq	40427	26°16' N	50°38' E	2	366	426
	Oman						
34	Masirah	40564	20°41' N	58°54' E	21	330	392
	Morocco						
35	Kenitra	60120	34°18' N	06°36' W	5	1502	2057
36	Meknes	60150	33°52' N	05°31' W	576	364	446
37	Casablanca	60155	33°34' N	07°40' W	61	379	457
38	Agadir	60250	30°23' N	09°33' W	25	333	449
39	Ouarzazate	60265	30°56' N	06°54' W	1139	116	203
	Tunisia						
40	Tunis	60715	36°51' N	10°14' E	6	314	403
41	Gafsa	60745	34°25' N	08°49' E	315	213	299
	Libya						
42	Zuwarah	62007	32°56' N	12°05' E	2	342	435
43	Tripoli/Wheelus AB	62011	32°40' N	13°10' E	80	1609	1710
44	Misratah	62016	32°25' N	15°06' E	5	372	448
45	Baninah	62053	32°06' N	20°17' E	129	423	579
46	Gialo	62161	29°02' N	21°33' E	61	297	539
47	Sabhah	62124	27°01' N	14°27' E	454	129	267
48	Kufrah	62271	24°13' N	38°18' E	407	326	505
	United Arab Republic						
49	Salum	62300	31°33' N	25°10' E	6	282	338
50	Alexanderia/Nouzha	62318	30°10' N	29°57' E	3	287	385
51	Port Said/El Gamil	62333	31°17' N	32°14' E	2	270	431
52	Cairo	62366	30°08' N	31°24' E	12	287	309
53	Manquabad	62393	27°11' N	31°05' E	71	346	405
54	Aswan	62414	23°58' N	32°49' E	200	280	304
	Canary Islands						
55	Santa Cruz de Teneriff	60020	28°28' N	16°15' W	36	68	351
56	Las Palmas	60030	27°56' N	15°23' W	25	230	278
	Spanish Sahara						
57	Villa Cisneros	60096	23°43' N	15°56' W	10	238	395

Table 2. Station Locator (continued)

Map Number	Station Name	WMO Number	Lat.	Long.	Altitude (m)	Number of Observations Min.	Max.
	Mauritania						
58	Fort Trinquet (Bir Moghreim)	61401	25°14' N	11°37' W	364	60	231
59	Atar	61421	20°30' N	13°08' W	229	77	240
60	Nouakchott	61442	18°06' N	15°57' W	2	120	263
61	Tidikja	61450	18°34' N	11°25' W	401	62	137
62	Aioun-El-Atrouss	61499	16°43' N	09°38' W	290	61	127
	Senegal						
63	Matam	61630	15°36' N	13°19' W	26	80	179
64	Dakar	61641	14°44' N	17°29' W	27	85	161
65	Tambacounda	61687	13°44' N	13°39' W	49	82	147
	Mali						
66	Bougouni	61296	11°27' N	07°31' W	357	97	201
67	Segou	61272	13°26' N	06°17' W	288	278	485
68	Tomboucto	61223	16°43' N	03°00' W	263	61	348
69	Tessalit	61202	20°12' N	00°59' E	494	96	439
	Upper Volta						
70	Bobo Dioulasso	65510	11°10' N	04°19' W	460	133	285
71	Ouahigouya	65502	13°34' N	02°25' W	337	115	233
	Niger						
72	Niamey	61052	13°29' N	02°10' E	223	328	467
73	Maradi	61080	13°30' N	07°08' E	378	165	285
74	Agadez	61024	16°58' N	08°00' E	505	186	455
75	Bilma	61017	18°41' N	12°55' E	357	65	442
76	N-Guigmi	61049	14°16' N	13°06' E	268	58	74
	Sierra Leone						
77	Freetown	61856	08°37' N	13°12' W	25	80	147
	Liberia						
78	Roberts Apt	65660	06°14' N	10°22' W	9	70	149
	Ivory Coast						
79	Bouake	65555	07°44' N	05°04' W	376	128	270
80	Tabou	65592	04°26' N	07°22' W	9	122	264
	Ghana						
81	Kumasi	65442	06°43' N	01°35' W	287	65	135
82	Takoradi	65467	04°54' N	01°46' W	6	88	157
	Togo						
83	Sansanne/Mango	65352	10°22' N	00°28' E	145	96	240
84	Tabligbo	65380	06°43' N	01°35' E	287	125	206

Table 2. Station Locator (continued)

Map Number	Station Name	WMO Number	Lat.	Long.	Altitude (m)	Number of Observations Min.	Max.
	Dahomey						
85	Kandi	65306	11°09' N	02°57' E	290	99	253
86	Cotonou	65344	06°21' N	02°23' E	5	115	334
	Nigeria						
87	Ilorin	65101	08°25' N	04°30' E	346	53	128
88	Jos	65134	09°52' N	08°54' E	1295	51	146
	Chad						
89	Ati	64751	13°15' N	18°18' E	332	90	230
90	Fort Lamy	64700	12°08' N	15°02' E	295	101	353
91	Bousso	64705	10°29' N	16°43' E	336	67	197
92	Moundou	64706	08°38' N	16°05' E	428	105	224
	Peoples Republic Congo						
93	Souanke	64460	02°00' N	14°10' E	525	61	143
94	Impfondo	64459	01°37' N	18°04' E	335	68	101
	Sudan						
95	Abu Hamed	62640	19°32' N	33°19' E	312	227	490
96	Khartoum	62721	15°36' N	32°33' E	383	257	563
97	Kassala	62730	15°23' N	36°21' E	354	208	523
98	Geneina	62770	13°33' N	22°28' E	805	176	403
99	Malakal	62840	09°33' N	31°39' E	387	219	483
100	Wau	62880	07°45' N	27°59' E	433	195	427
101	Juba	62941	04°52' N	31°36' E	460	216	475
	Ethiopia						
102	Gondar	63331	12°31' N	37°27' E	1967	50	122
103	Dire Dawa	63471	09°37' N	41°51' E	1164	54	210
104	Gore	63403	08°09' N	35°32' E	2006	58	150
	Uganda						
105	Entebbe	63705	00°03' N	32°26' E	1153	196	412
	Kenya						
106	Ludwar	63612	03°07' N	35°37' E	518	151	326
107	Mandera	63624	03°56' N	41°51' E	244	159	242
108	Nairobi	63740	01°19' S	36°56' E	1624	237	422
109	Mombasa	63820	04°02' S	39°36' E	56	221	313

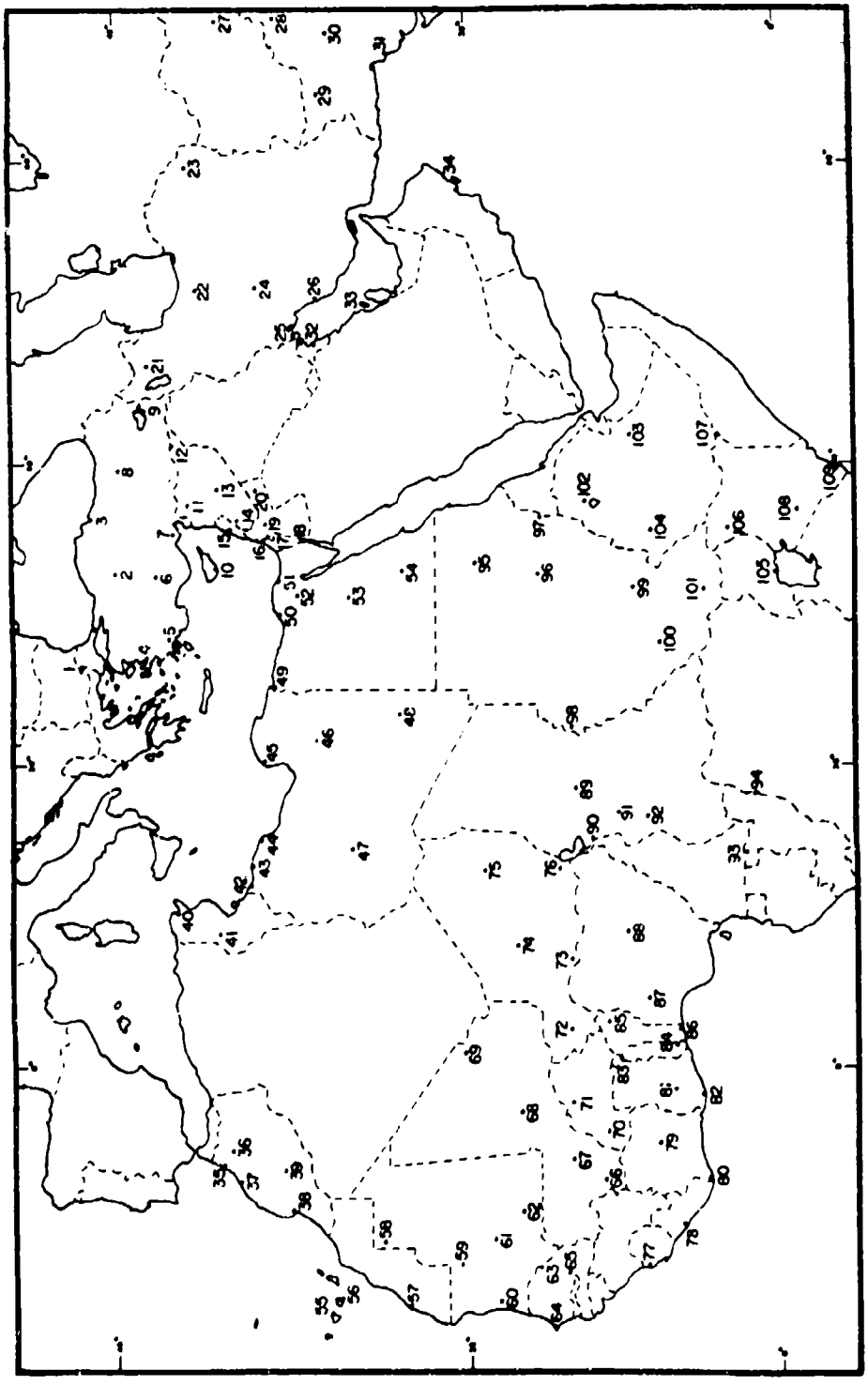

Figure 1. Station Locator Map

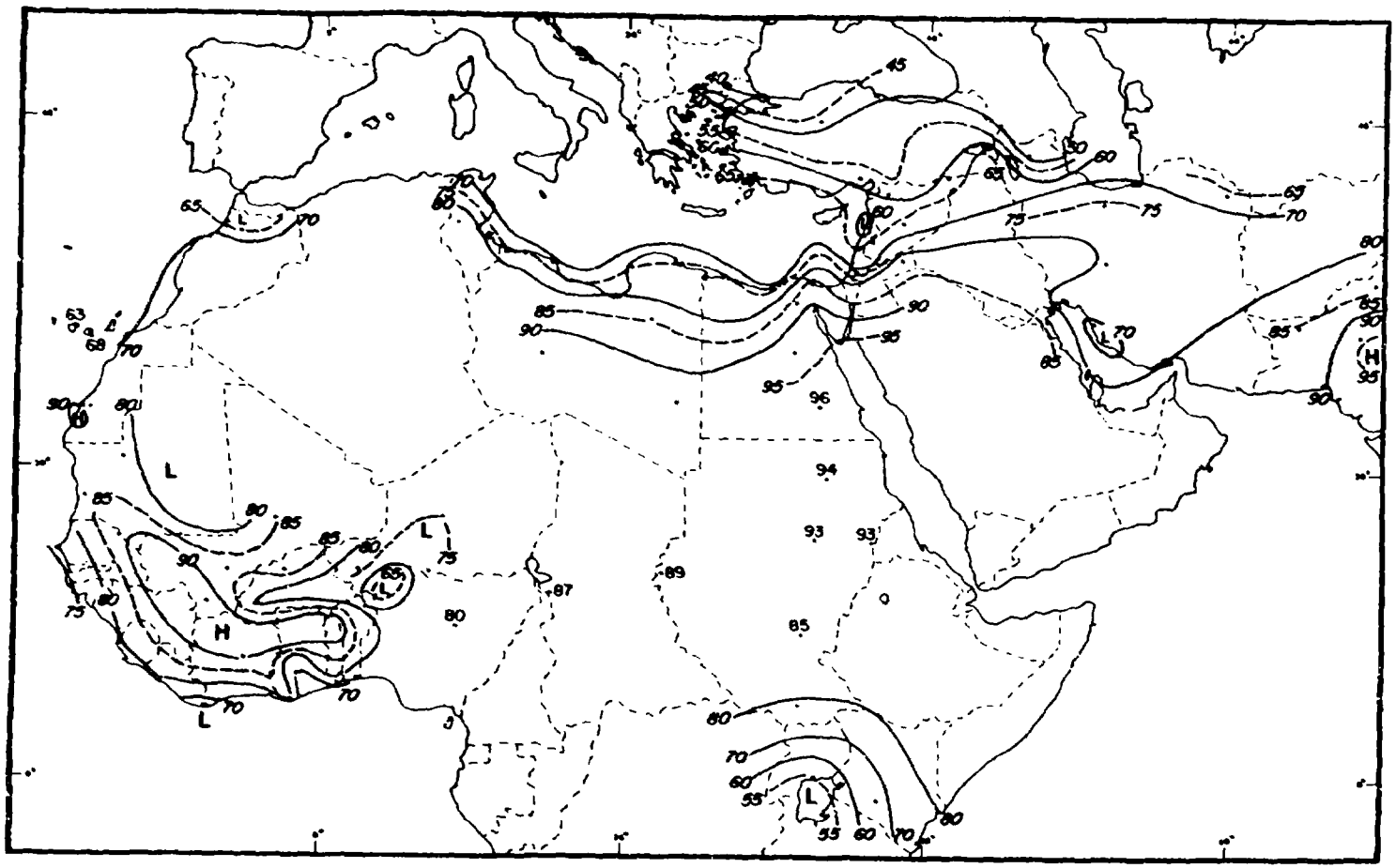

Figure 2. CFLOS Probabilities for Jan, 0000-0200 LST, 90° Elevation

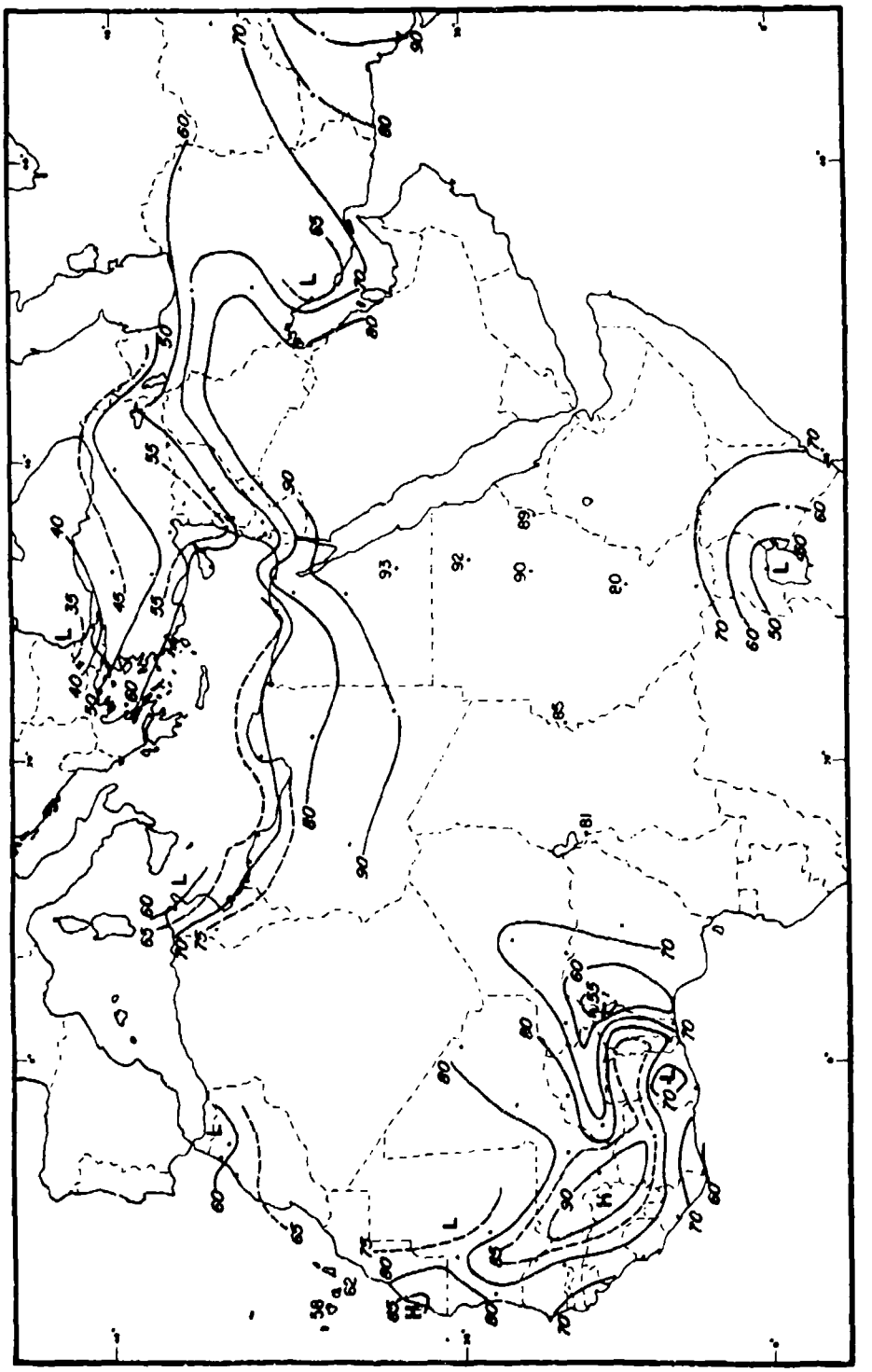

Figure 3. CFLOS Probabilities for Jan, 0000-0200 LST, 30° Elevation

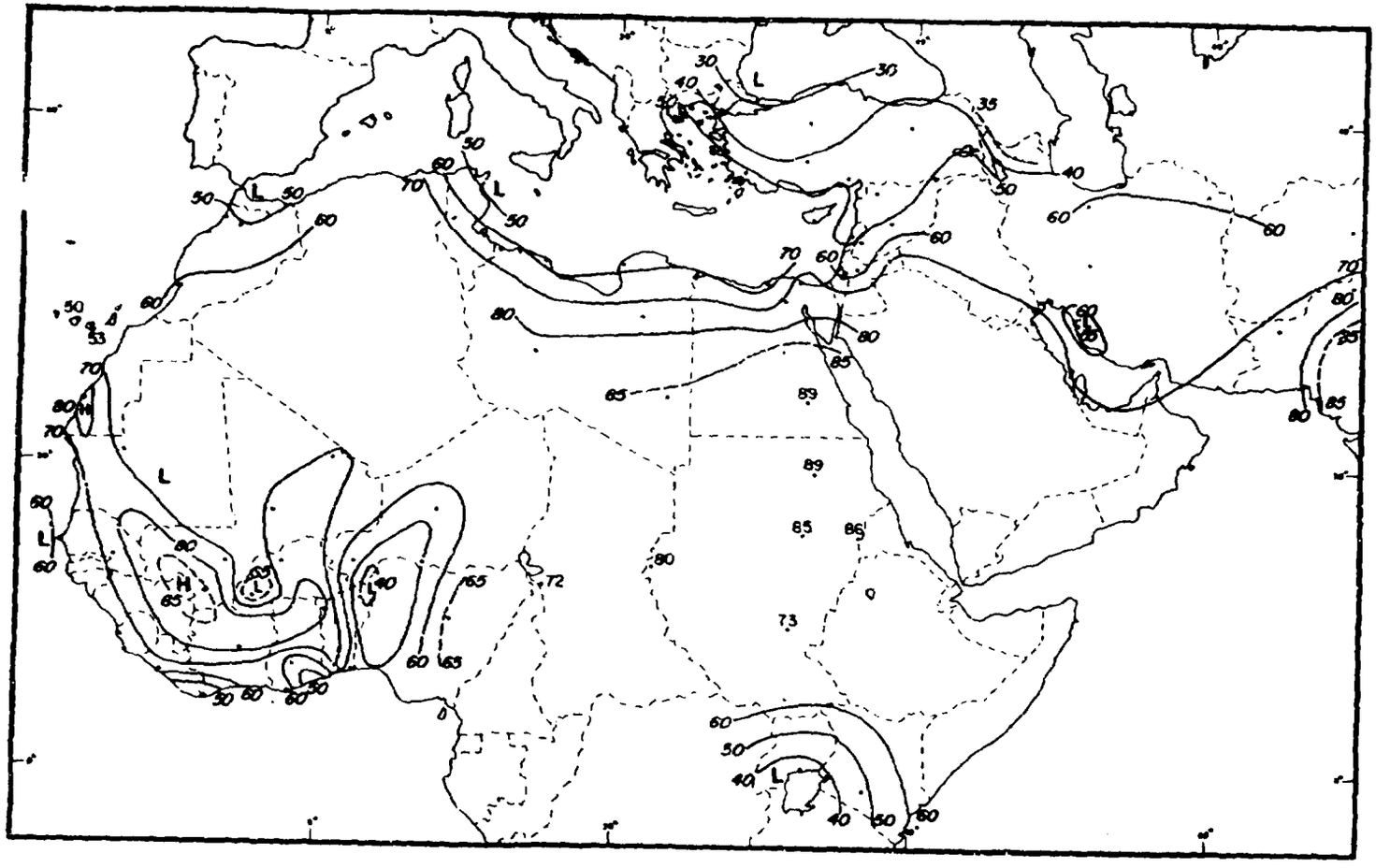

Figure 4. CFLOS Probabilities for Jan, 0000-0200 LST, 10° Elevation

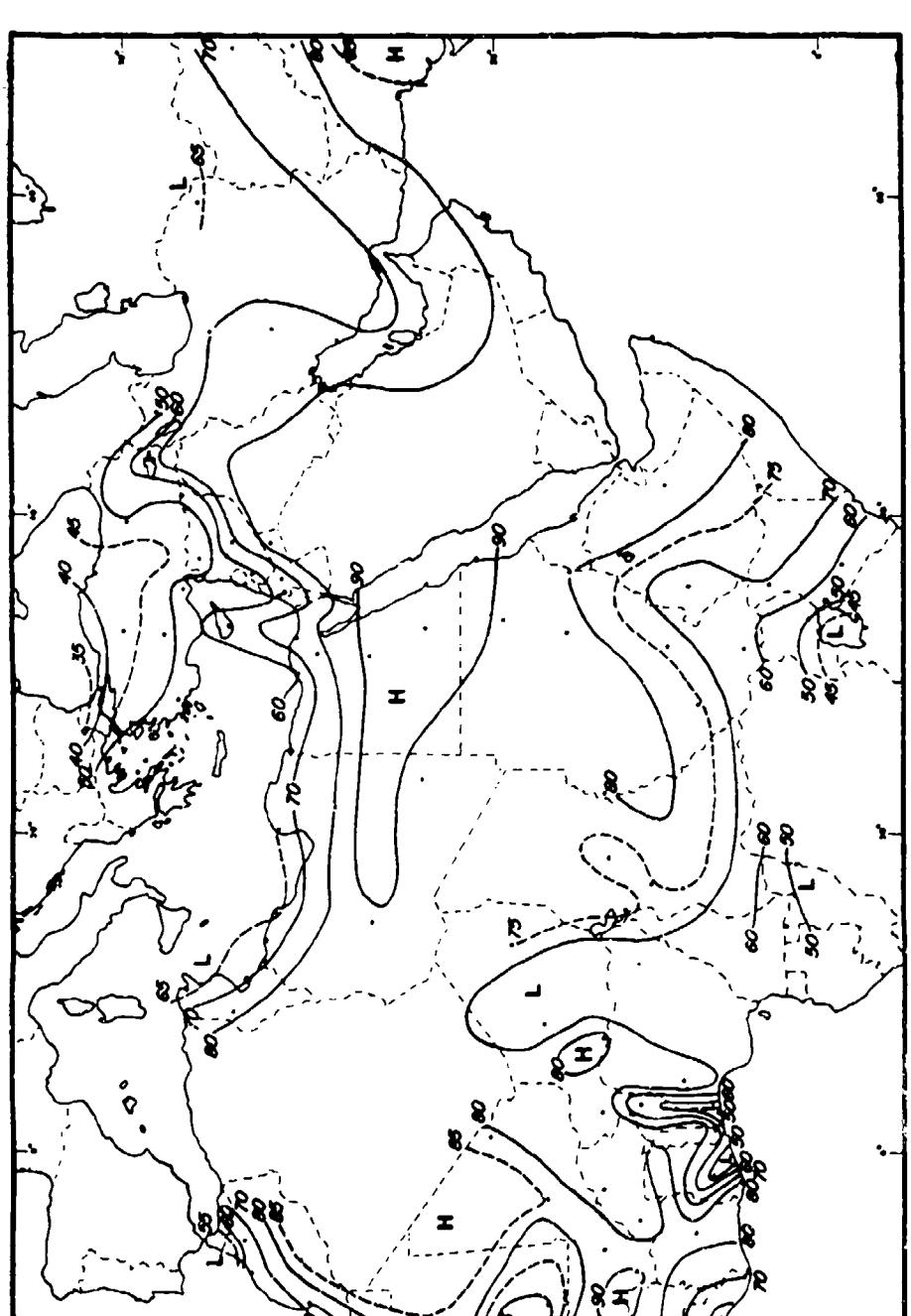

Figure 5. CFLOS Probabilities for Jan, 0600-0800 LST, 90° Elevation

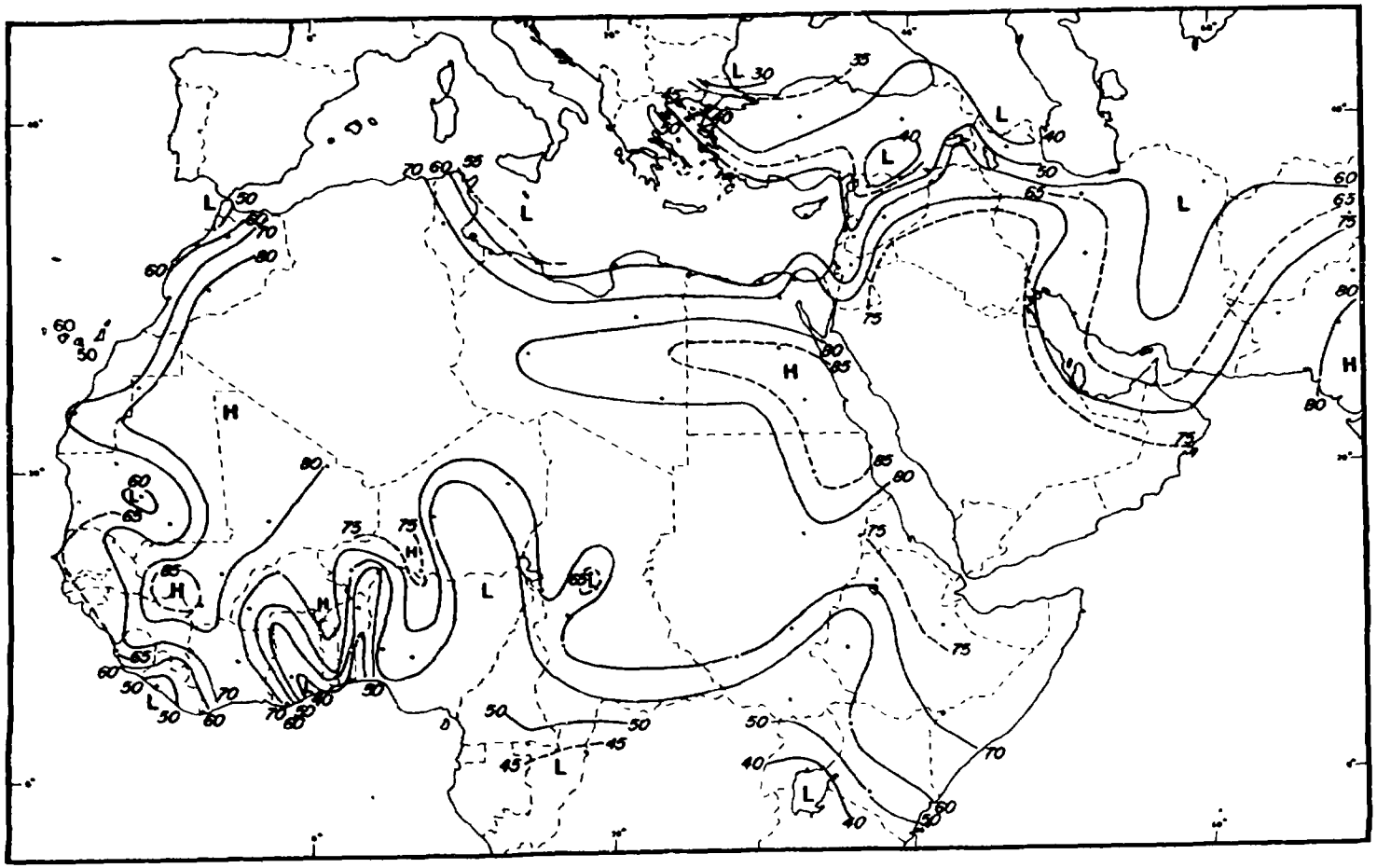

Figure 6. CFLOS Probabilities for Jan, 0600-0800 LST, 30° Elevation

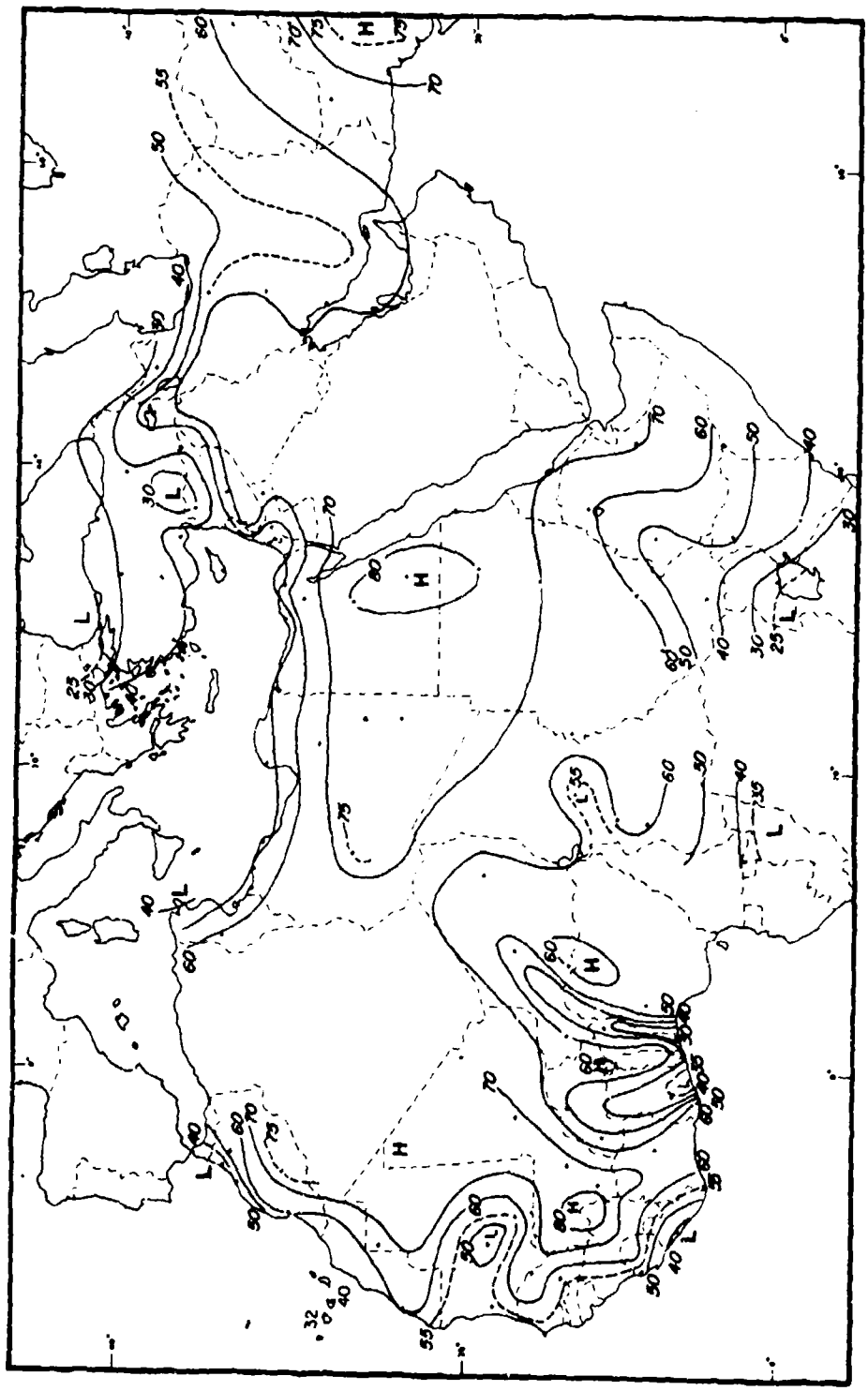

Figure 7. CFLOS Probabilities for Jan, 0600-0800 LST, 10° Elevation

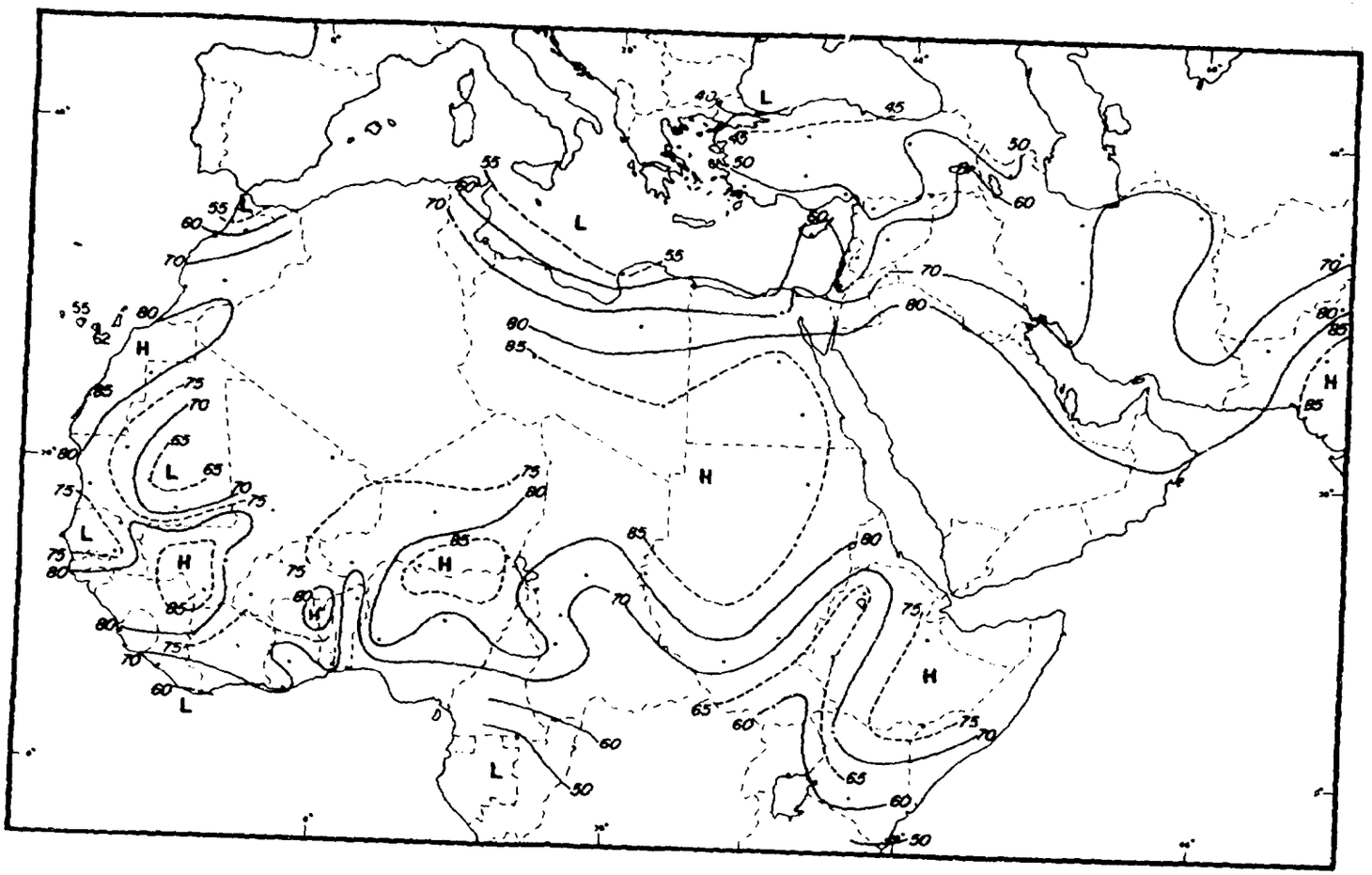

Figure 8. CFLOS Probabilities for Jan, 1200-1400 LST, 90° Elevation

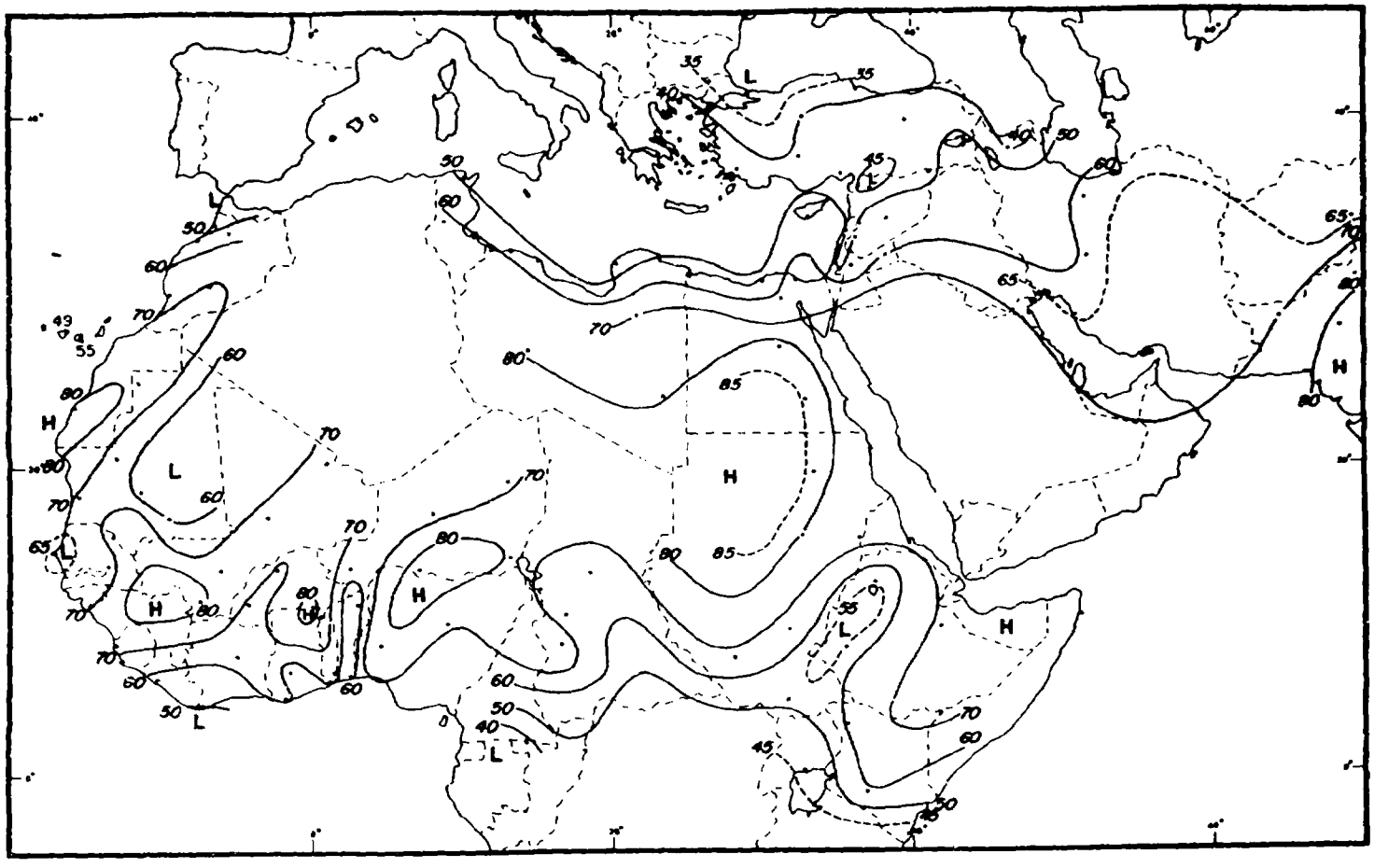

Figure 9. CFLOS Probabilities for Jan, 1200-1400 LST, 30° Elevation

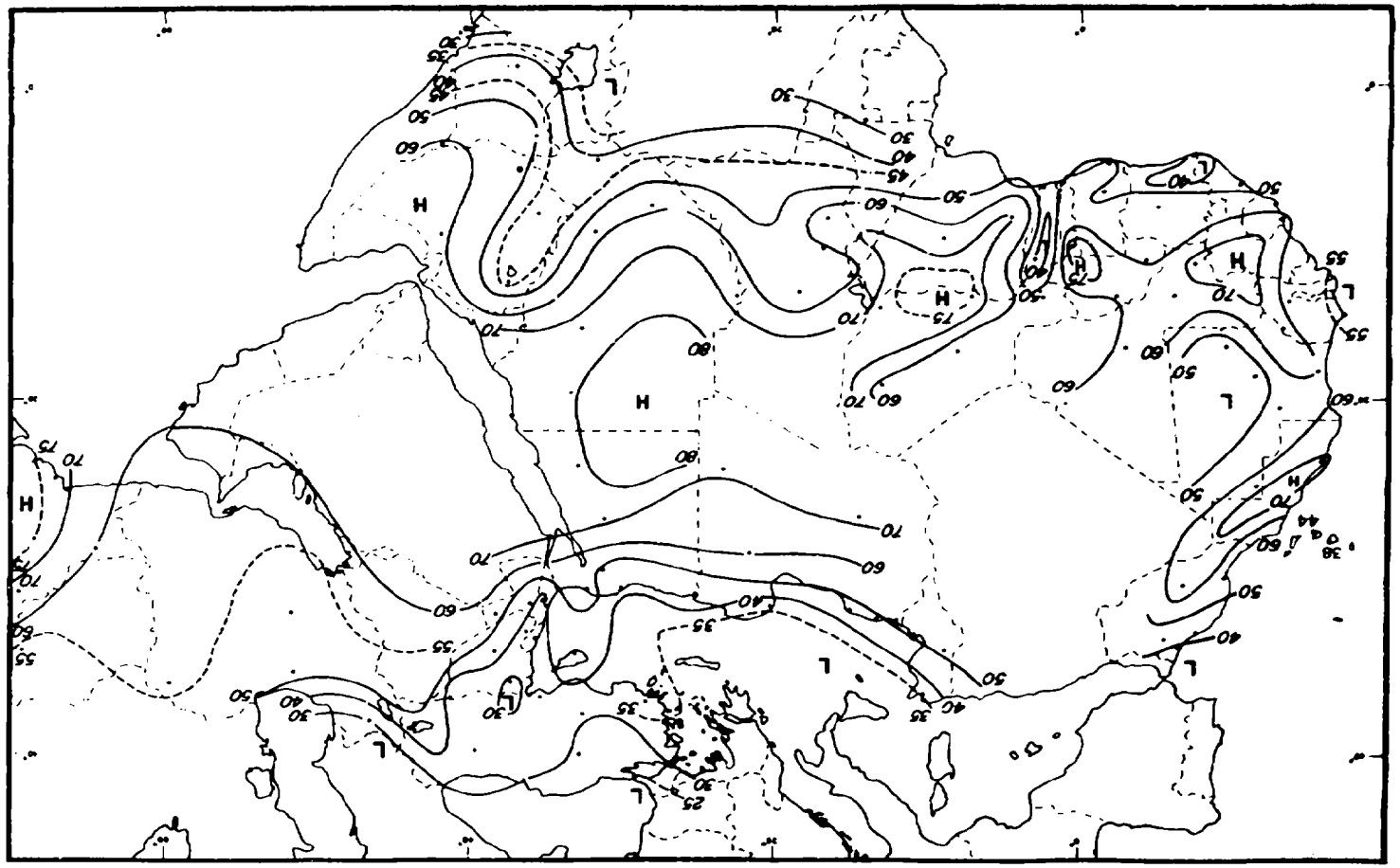

Figure 10. CFLOS Probabilities for Jan, 1200-1400 LST, 10° Elevation

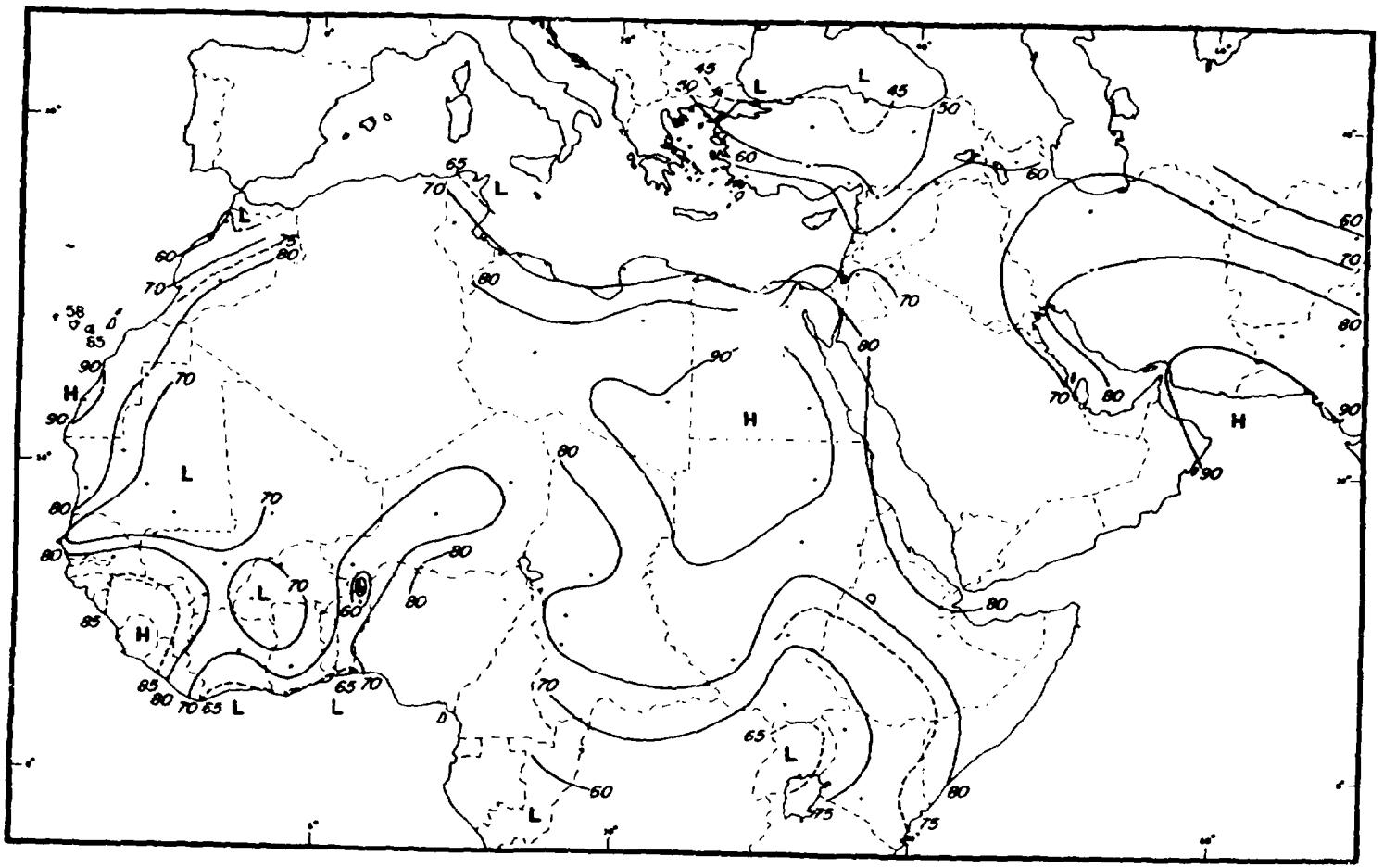

Figure 11. CFLOS Probabilities for Jan, 1800-2000 LST, 90° Elevation

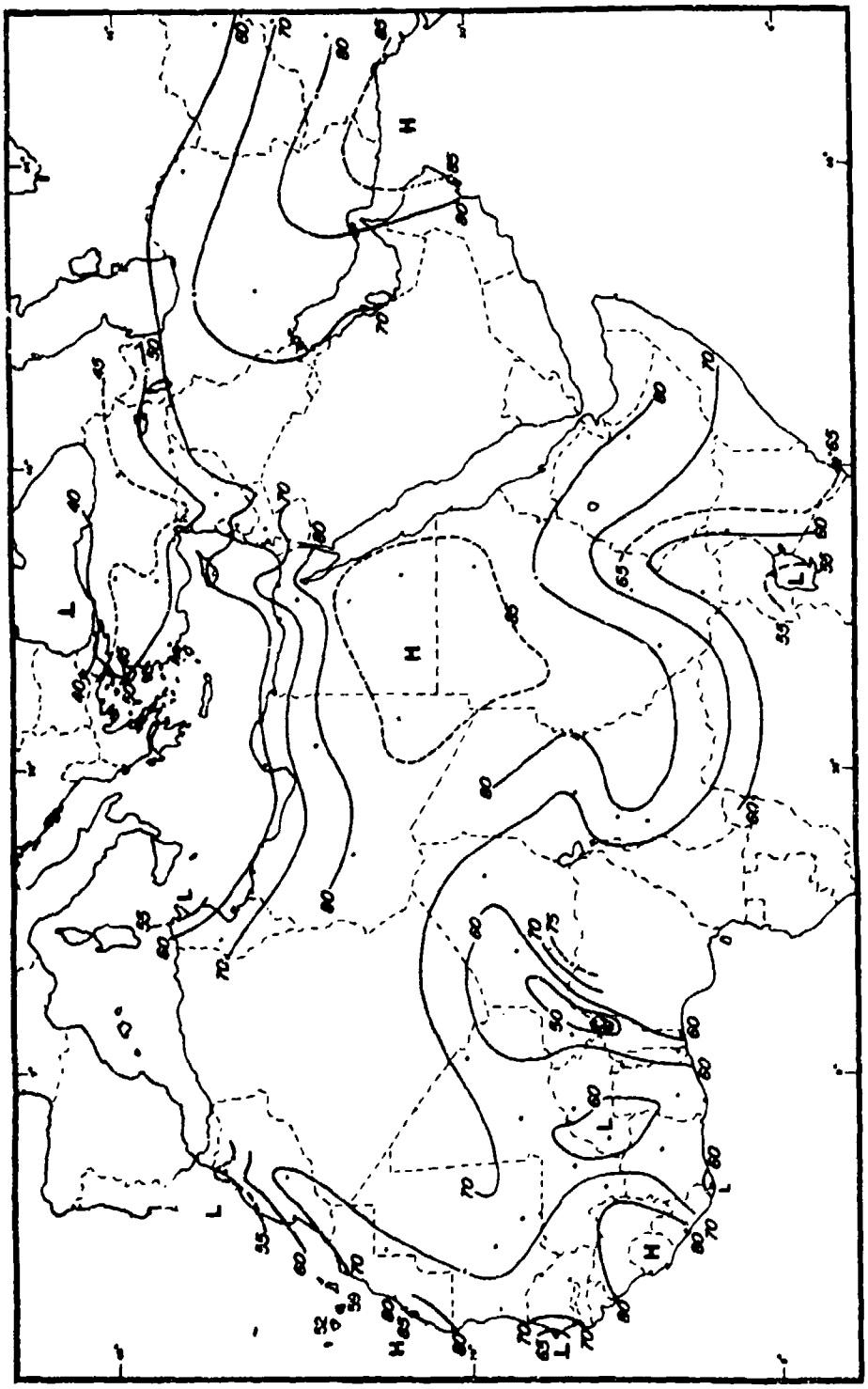

Figure 12. CFLOS Probabilities for Jan, 1800-2000 LST, 30° Elevation

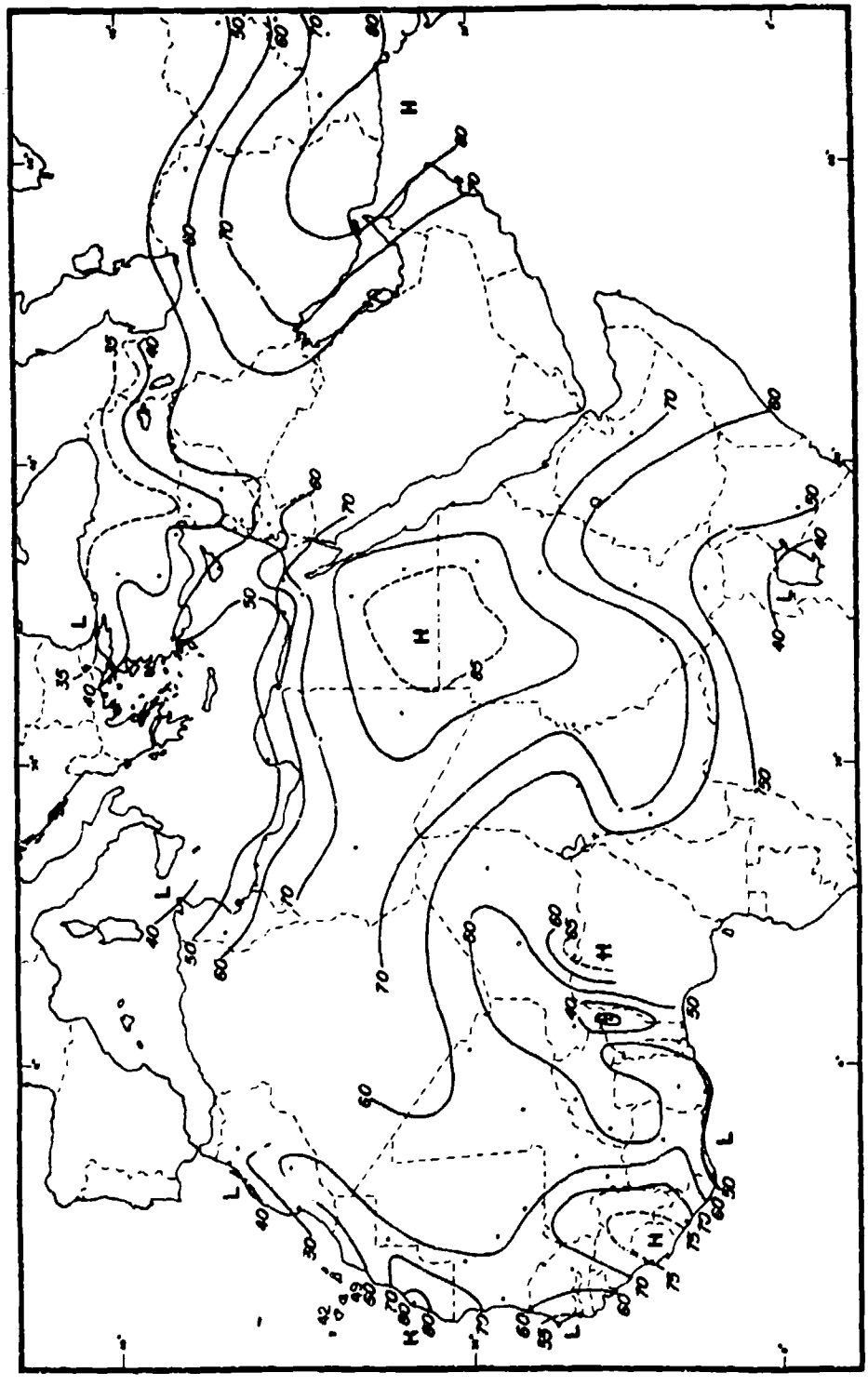

Figure 13. CFLOS Probabilities for Jan, 1800-2000 LST, 10° Elevation

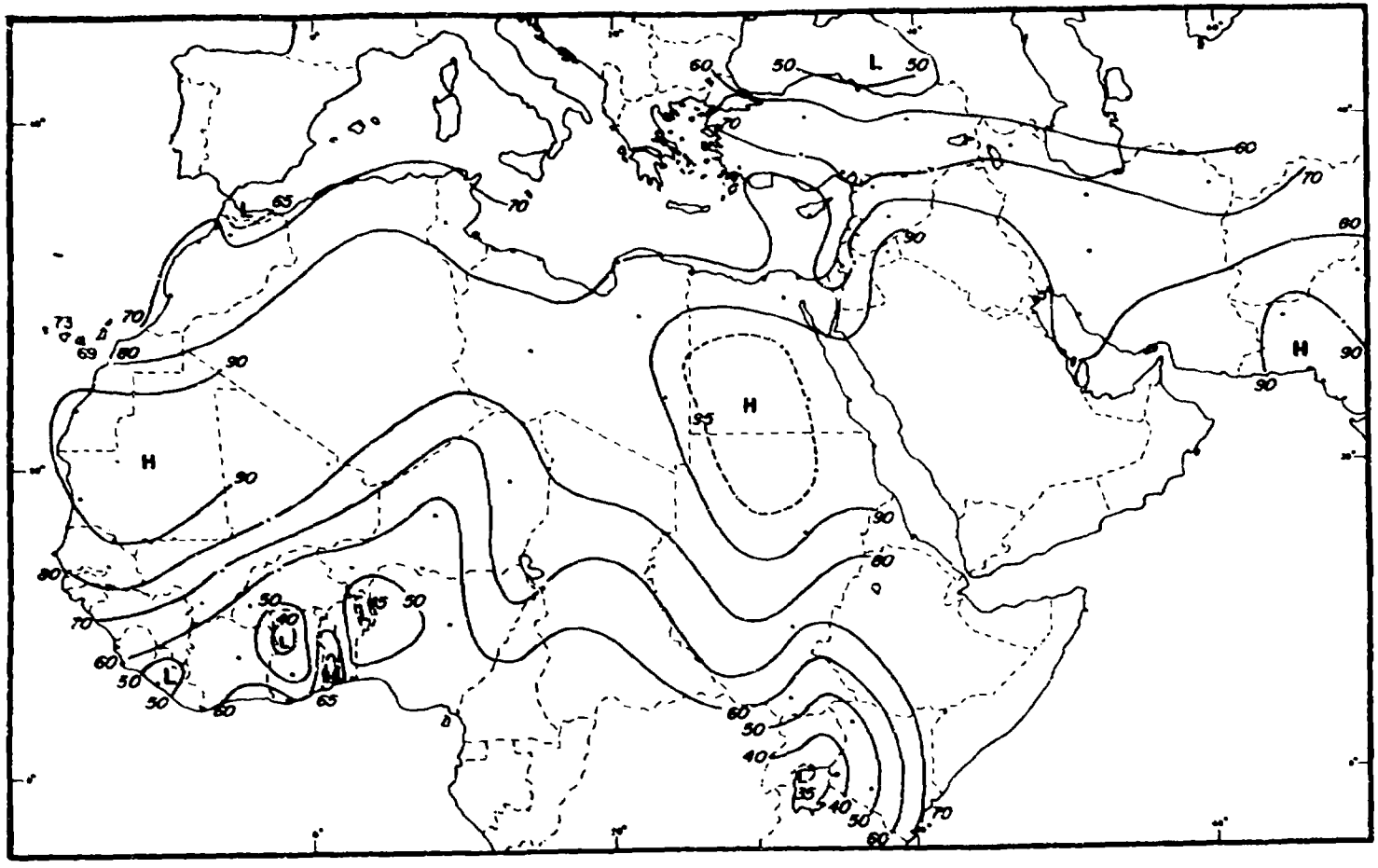

Figure 14. CFLOS Probabilities for Apr, 0000-0200 LST, 90° Elevation

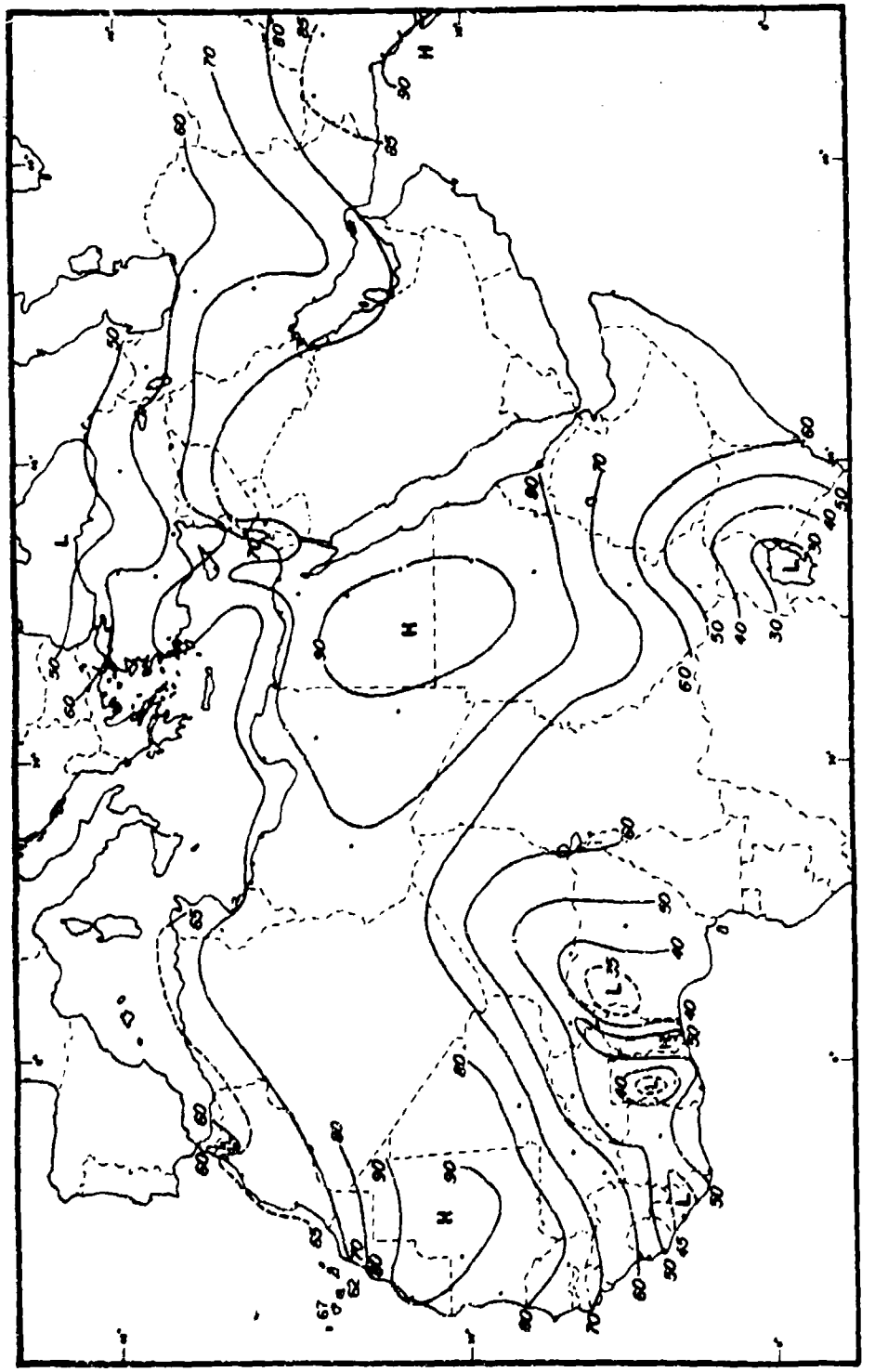

Figure 15. CFLOS Probabilities for Apr, 0000-0200 LST, 30° Elevation

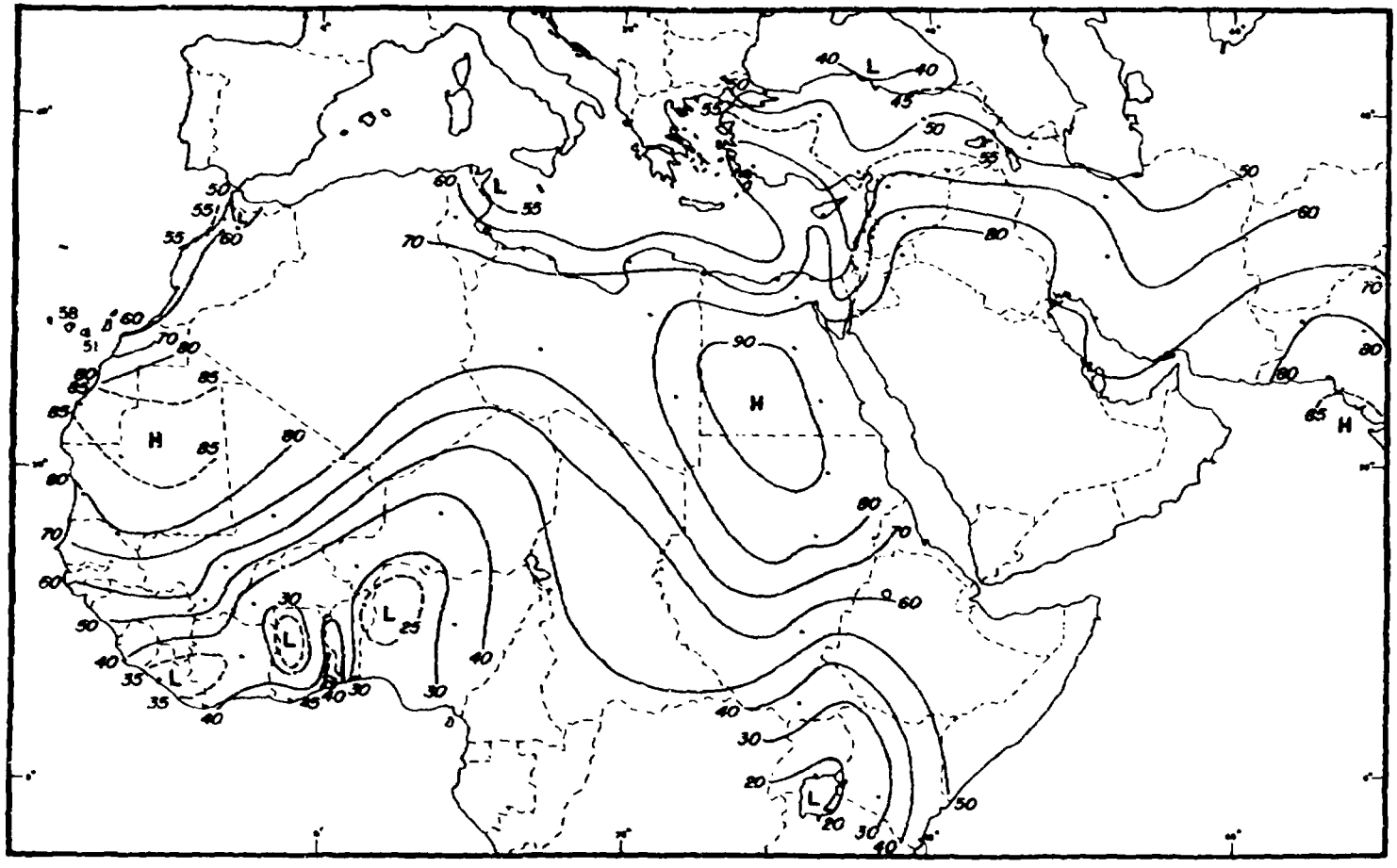

Figure 16. CFLOS Probabilities for Apr, 0000-0200 LST, 10° Elevati

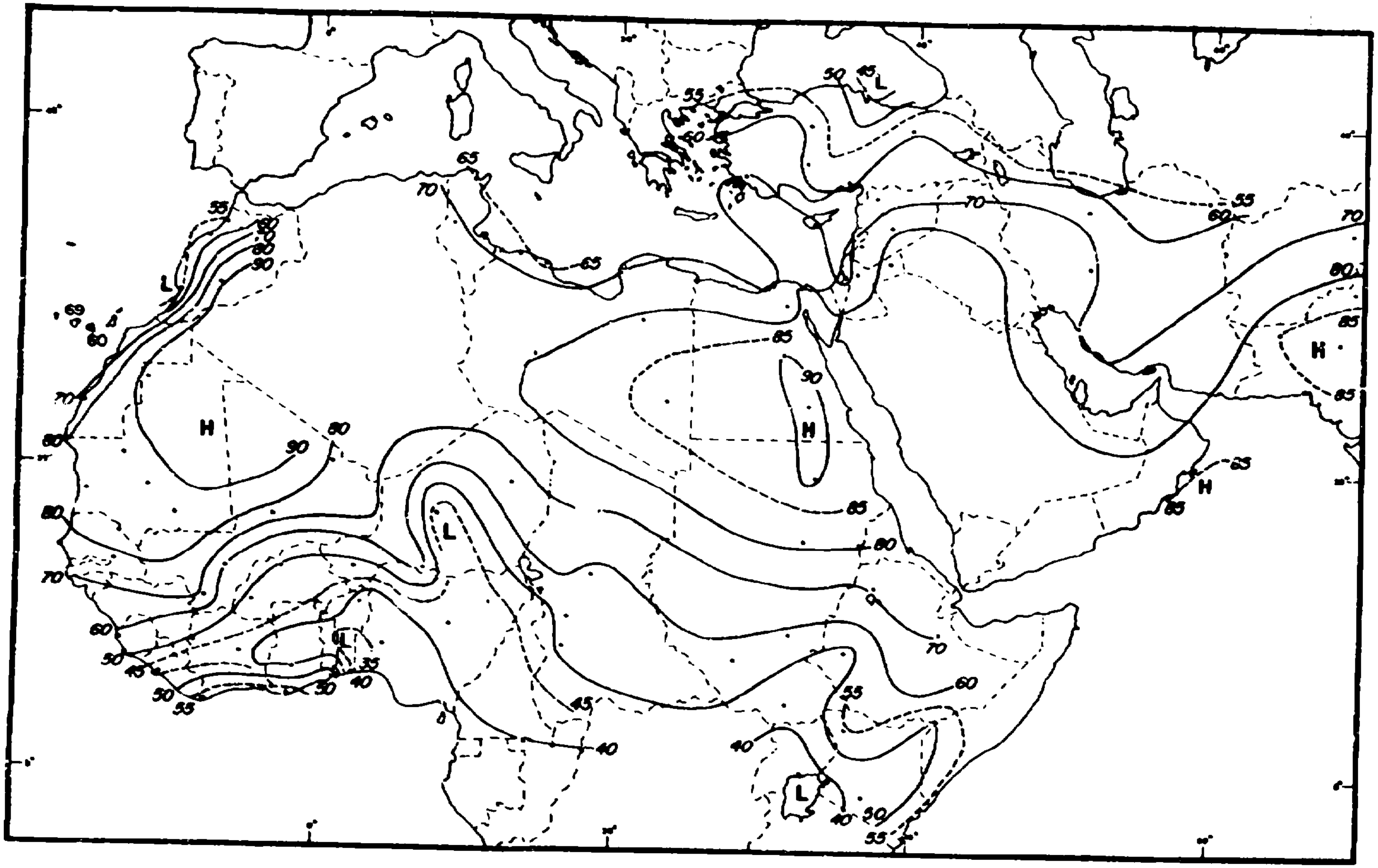

Figure 17. CFLOS Probabilities for Apr, 0600-0800 LST, 90° Elevation

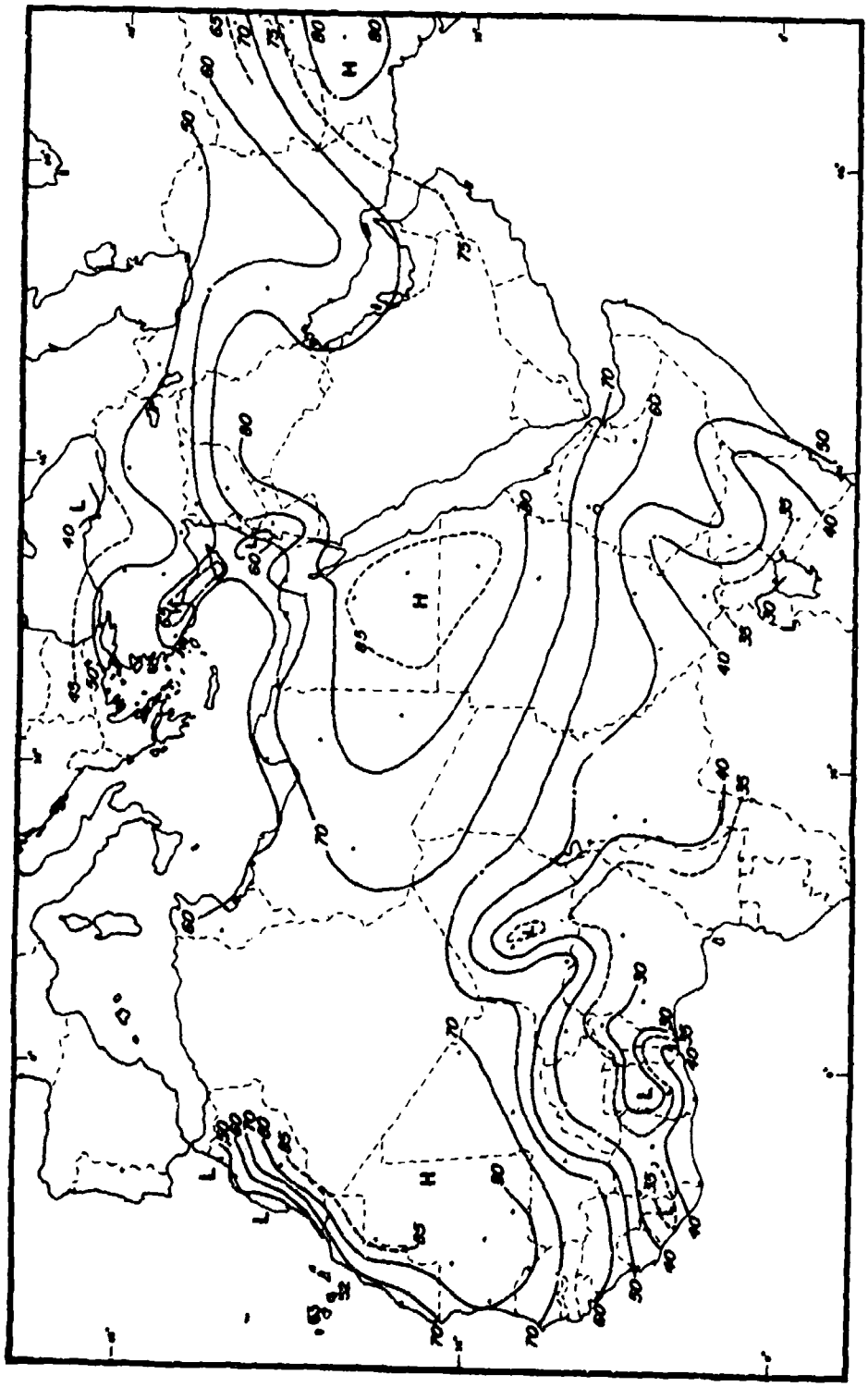

Figure 18. CFLOS Probabilities for Apr, 0600-0800 LST, 30° Elevation

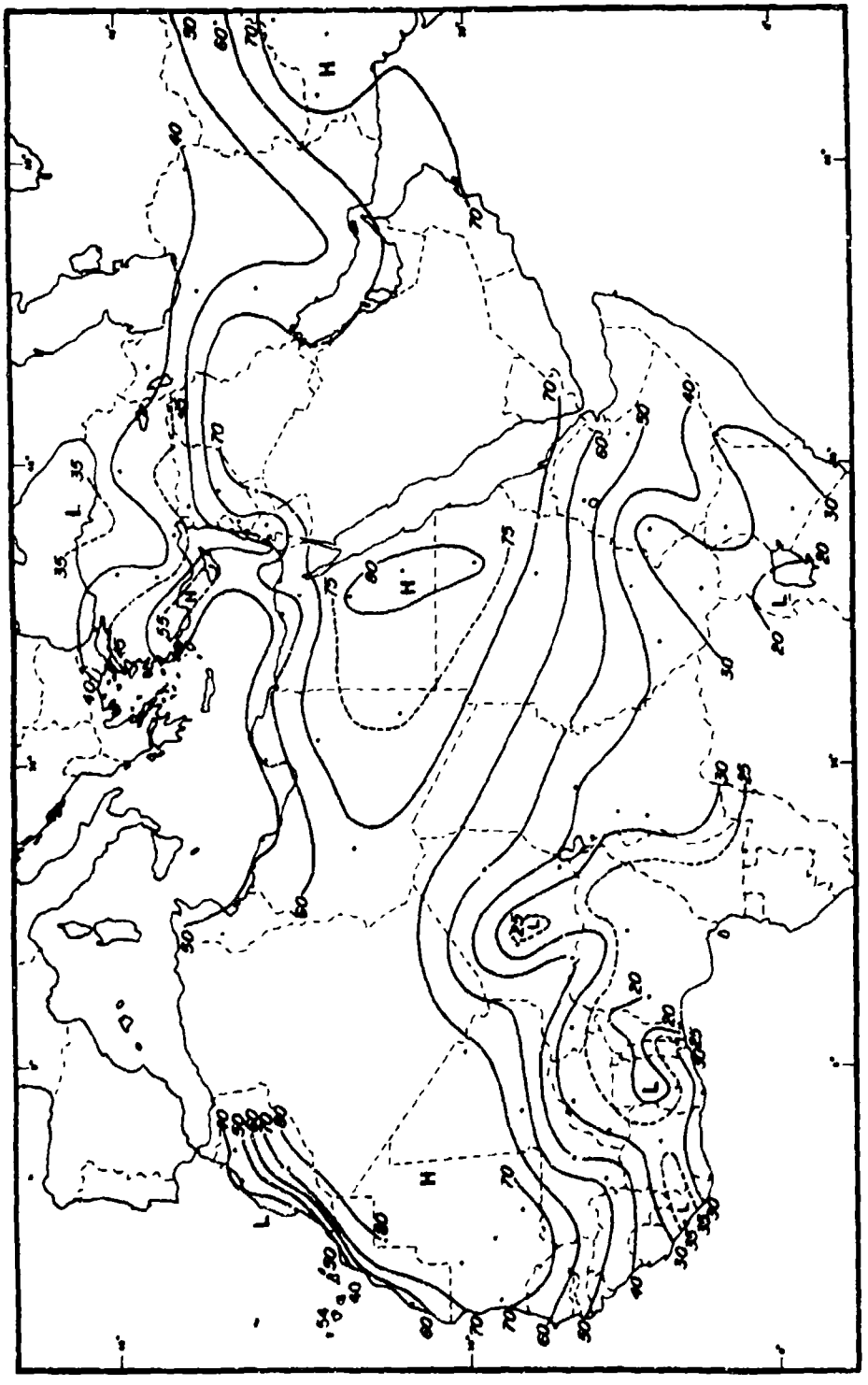

Figure 19. CFLOS Probabilities for Apr, 0600-0800 LST, 10° Elevation

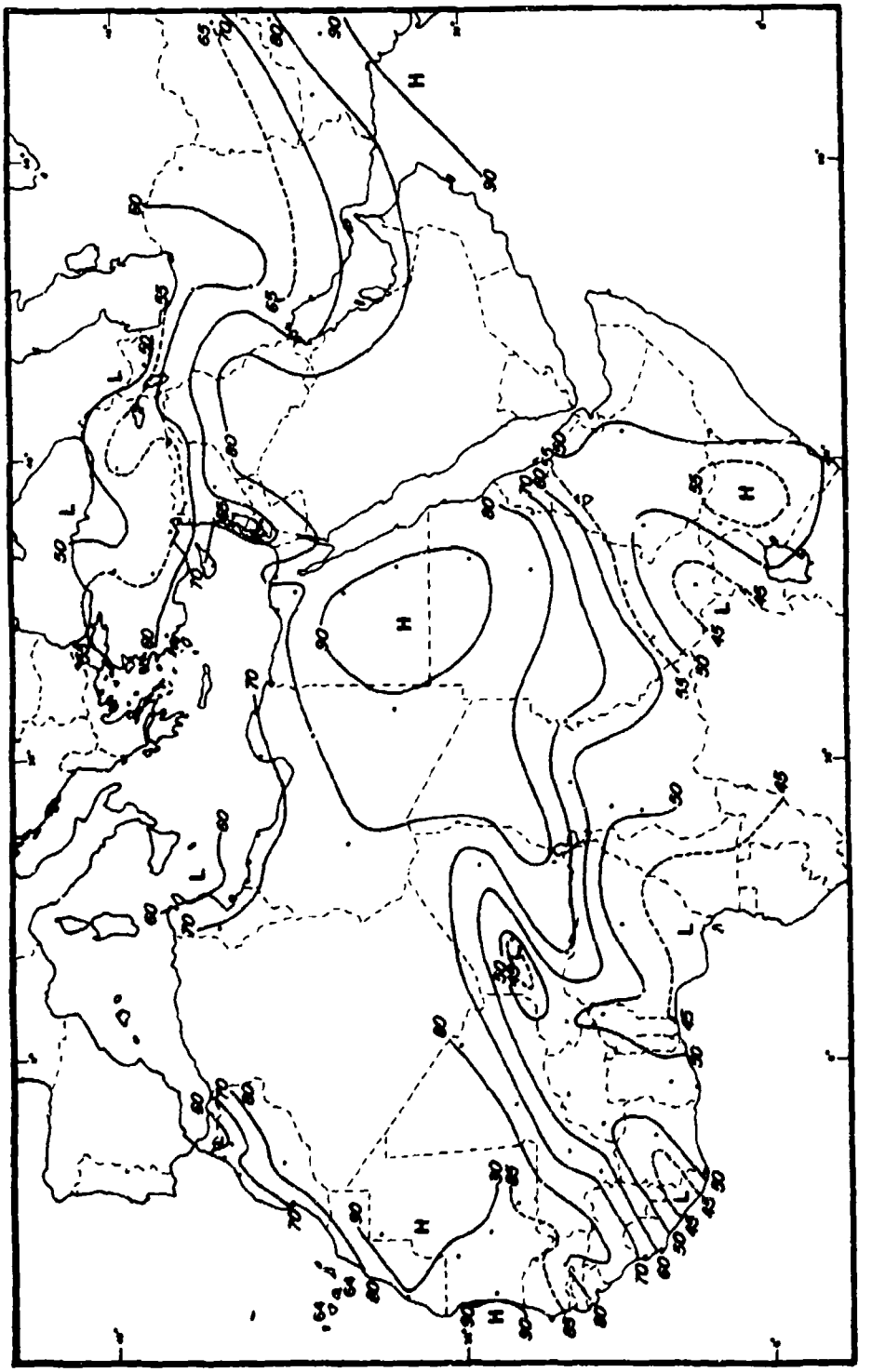

Figure 20. CFLOS Probabilities for Apr, 1200-1400 LST, 90° Elevation

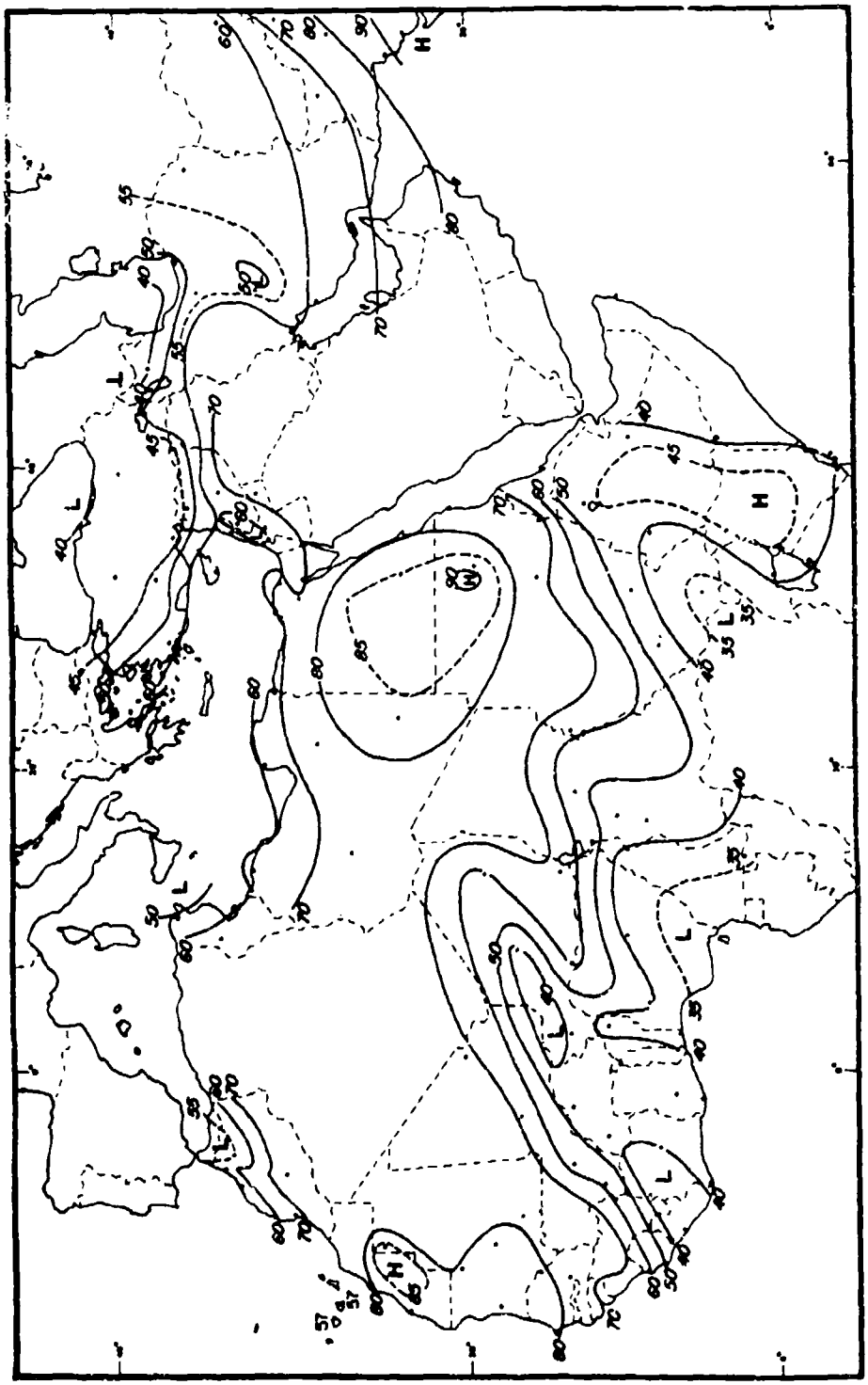

Figure 21. CFLOS Probabilities for Apr, 1200-1400 LST, 30° Elevation

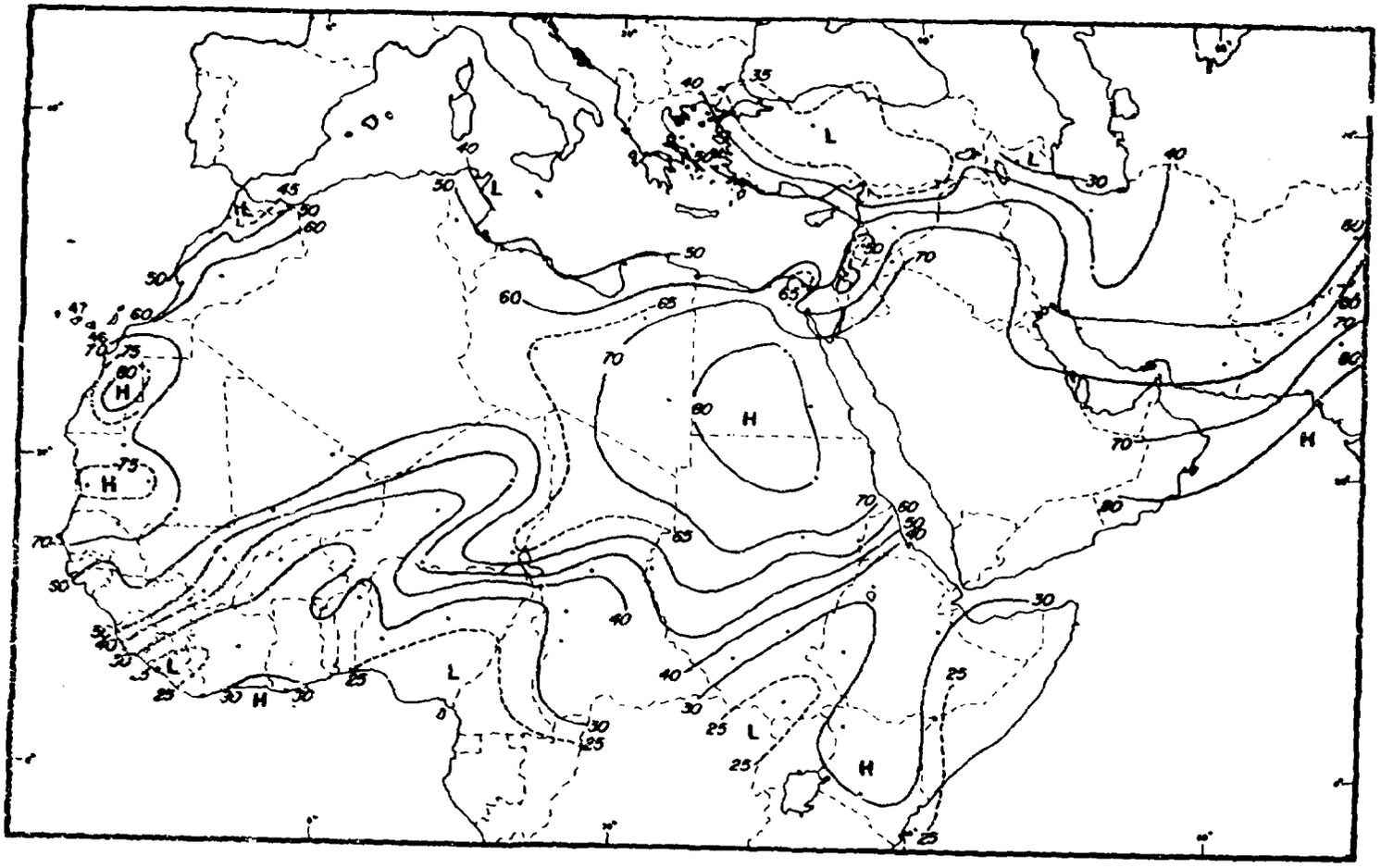

Figure 22. CFLOS Probabilities for Apr, 1200-1400 LST, 10° Elevation

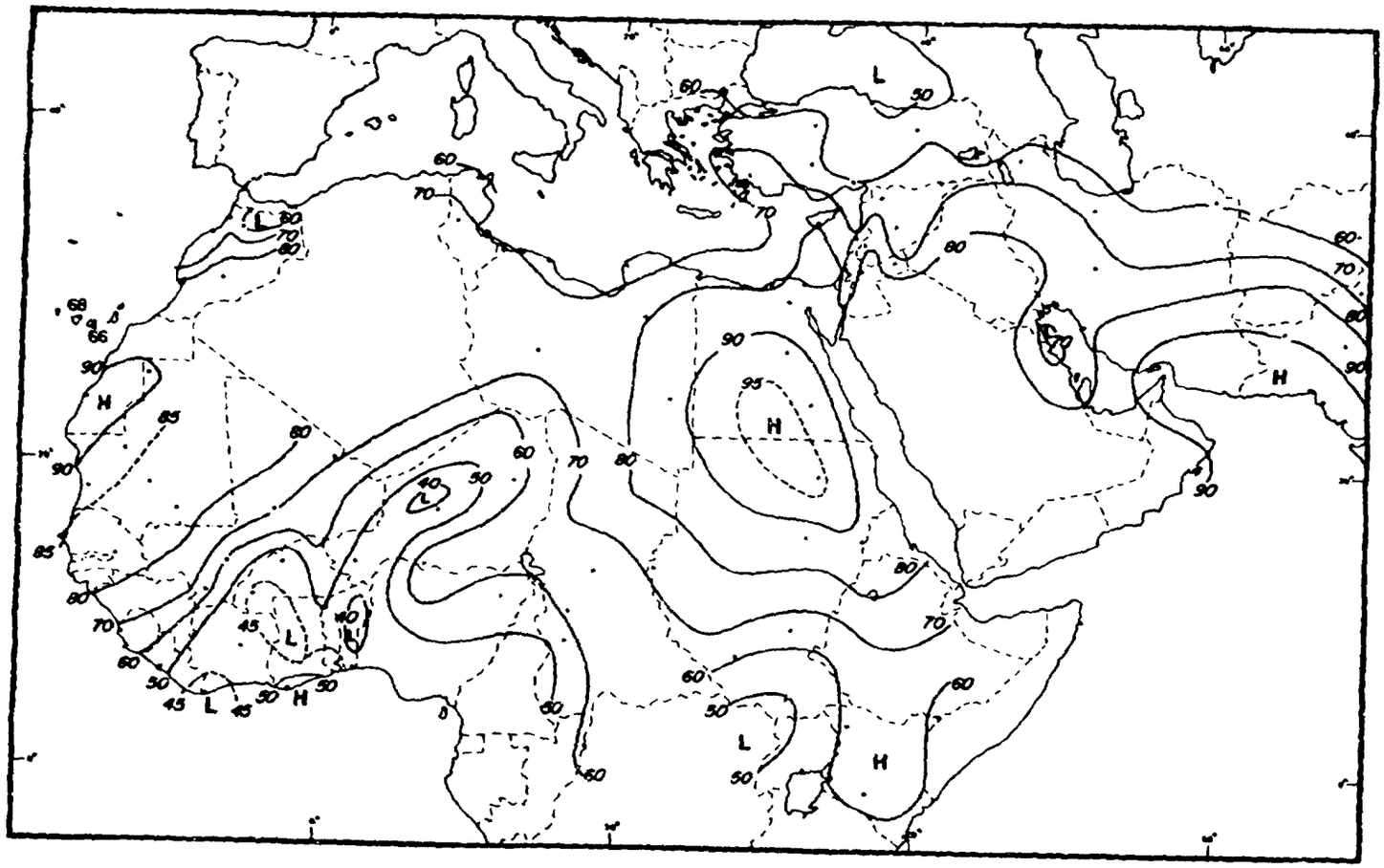

Figure 23. CFLOS Probabilities for Apr, 1800-2000 LST, 90° Elevation

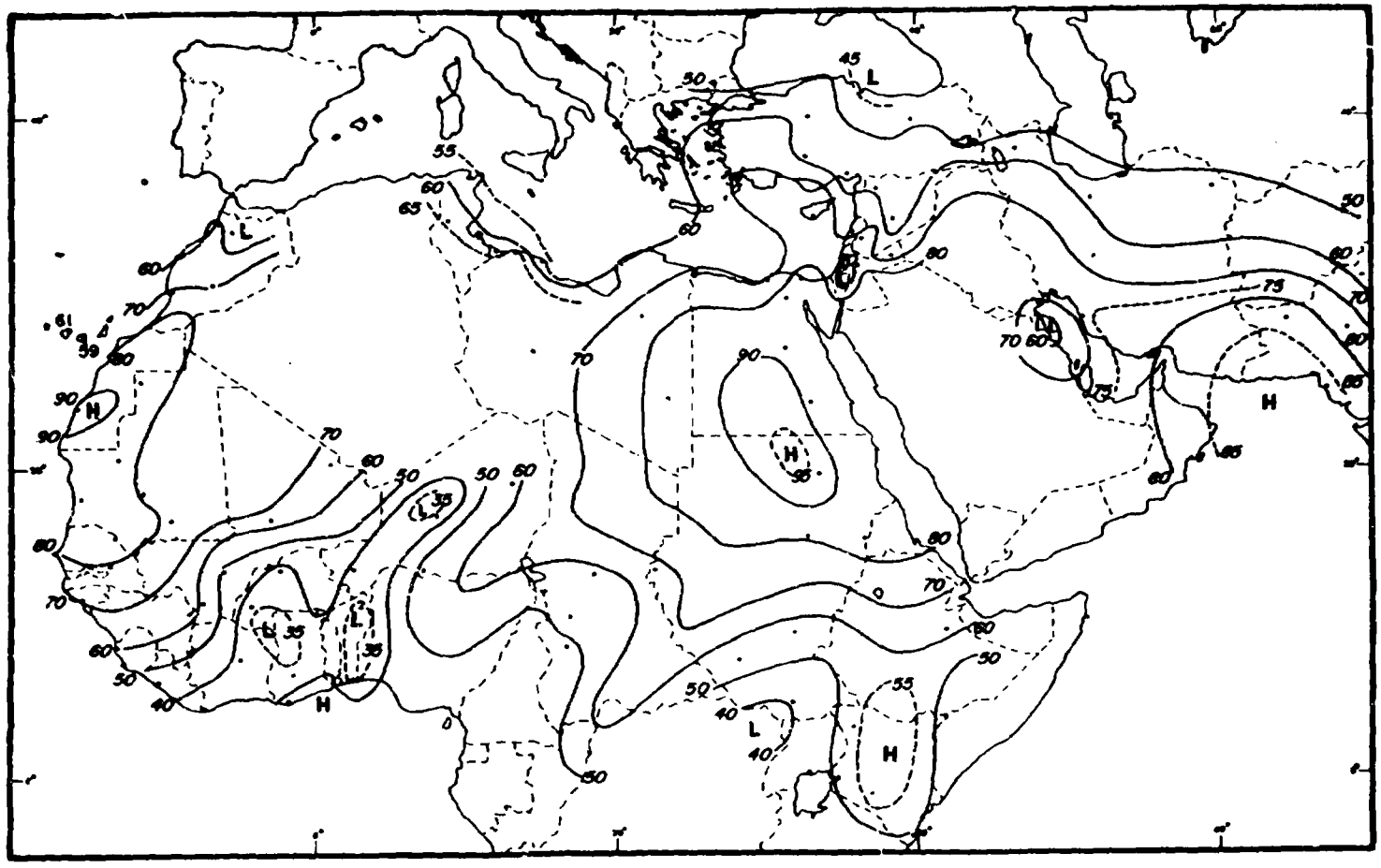

Figure 24. CFLOS Probabilities for Apr, 1800-2000 LST, 30° Elevation

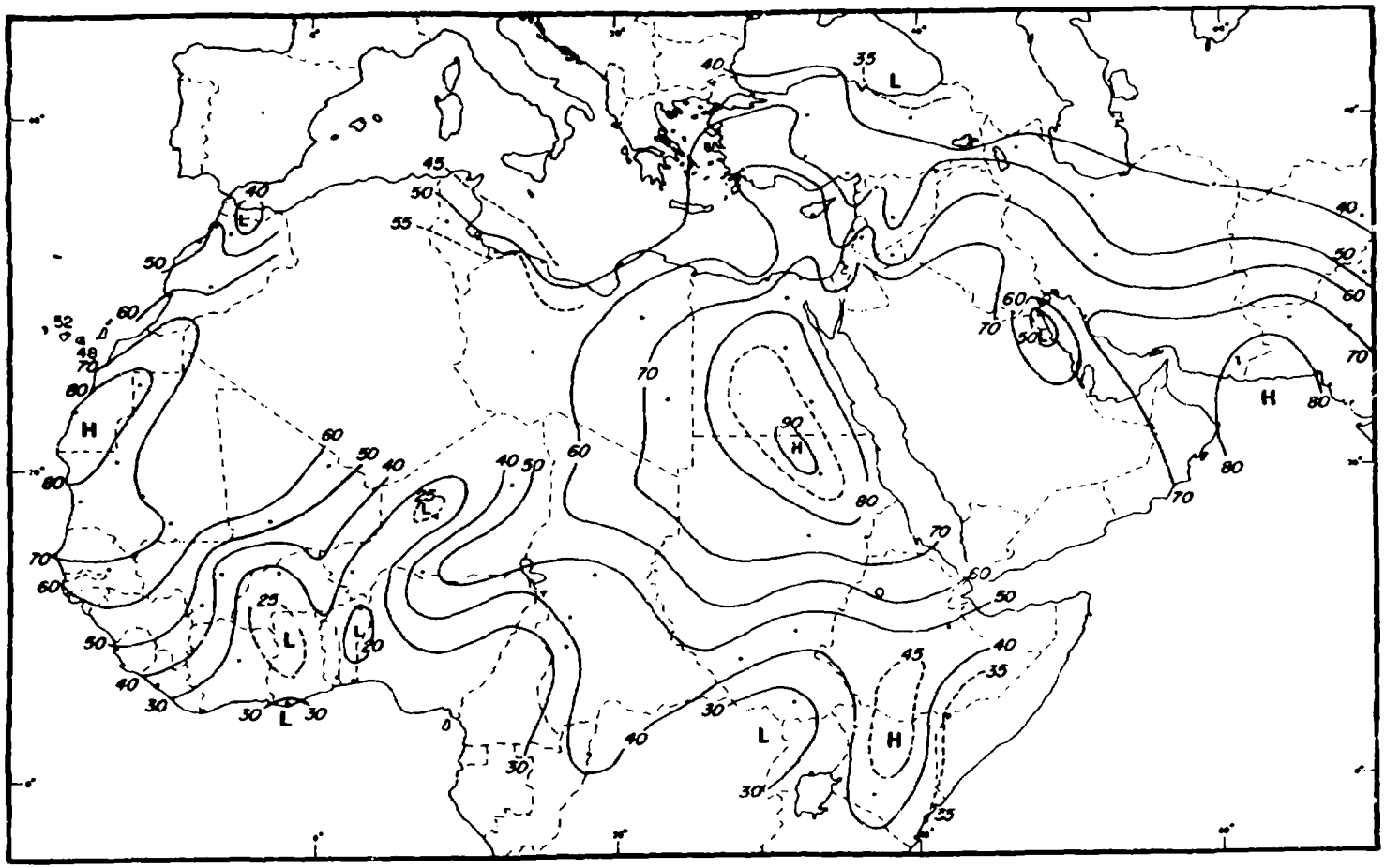

Figure 25. CFLOS Probabilities for Apr, 1800-2000 LST, 10° Elevation

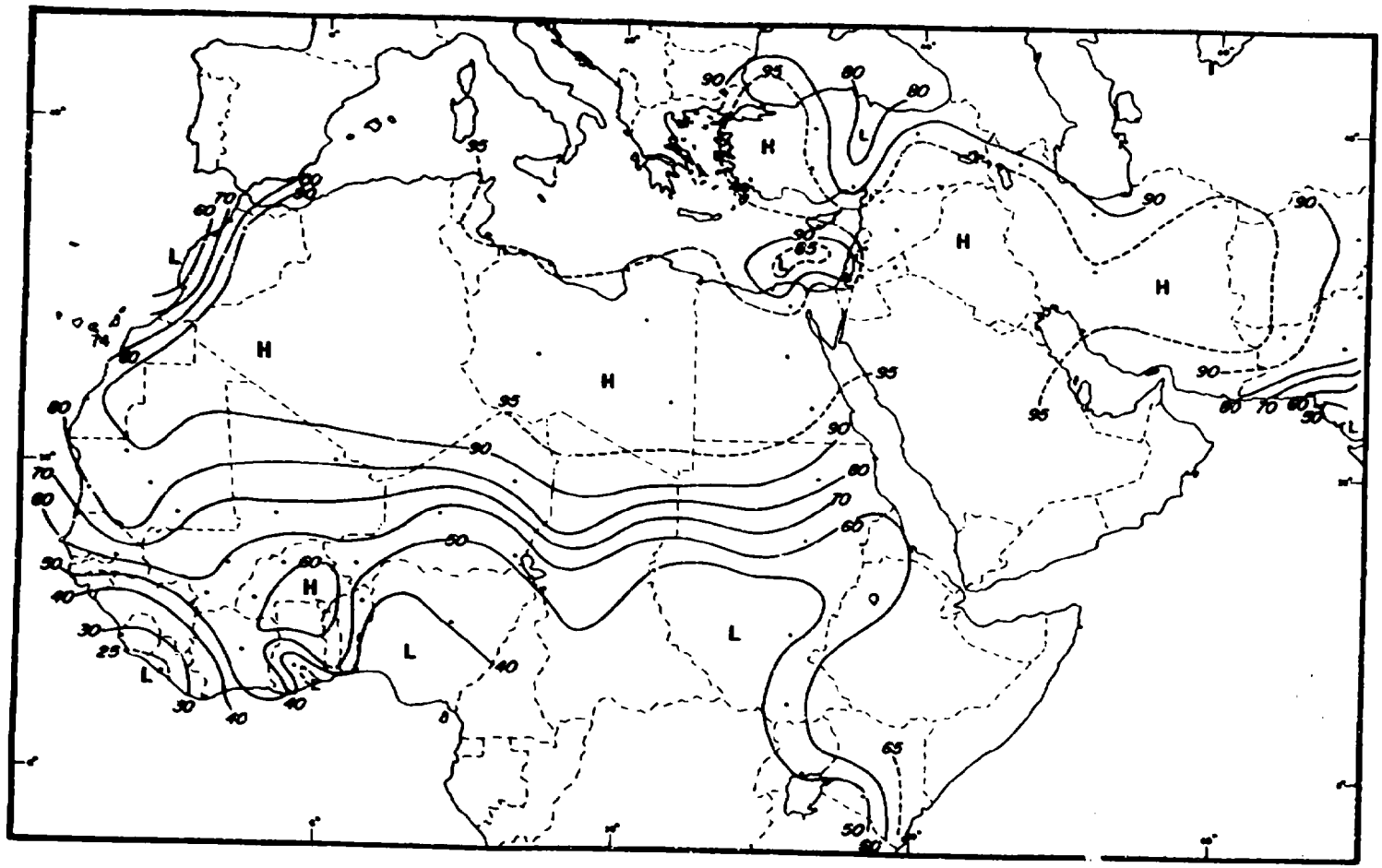

Figure 26. CFLOS Probabilities for July, 0000-0200 LST, 90° Elevation

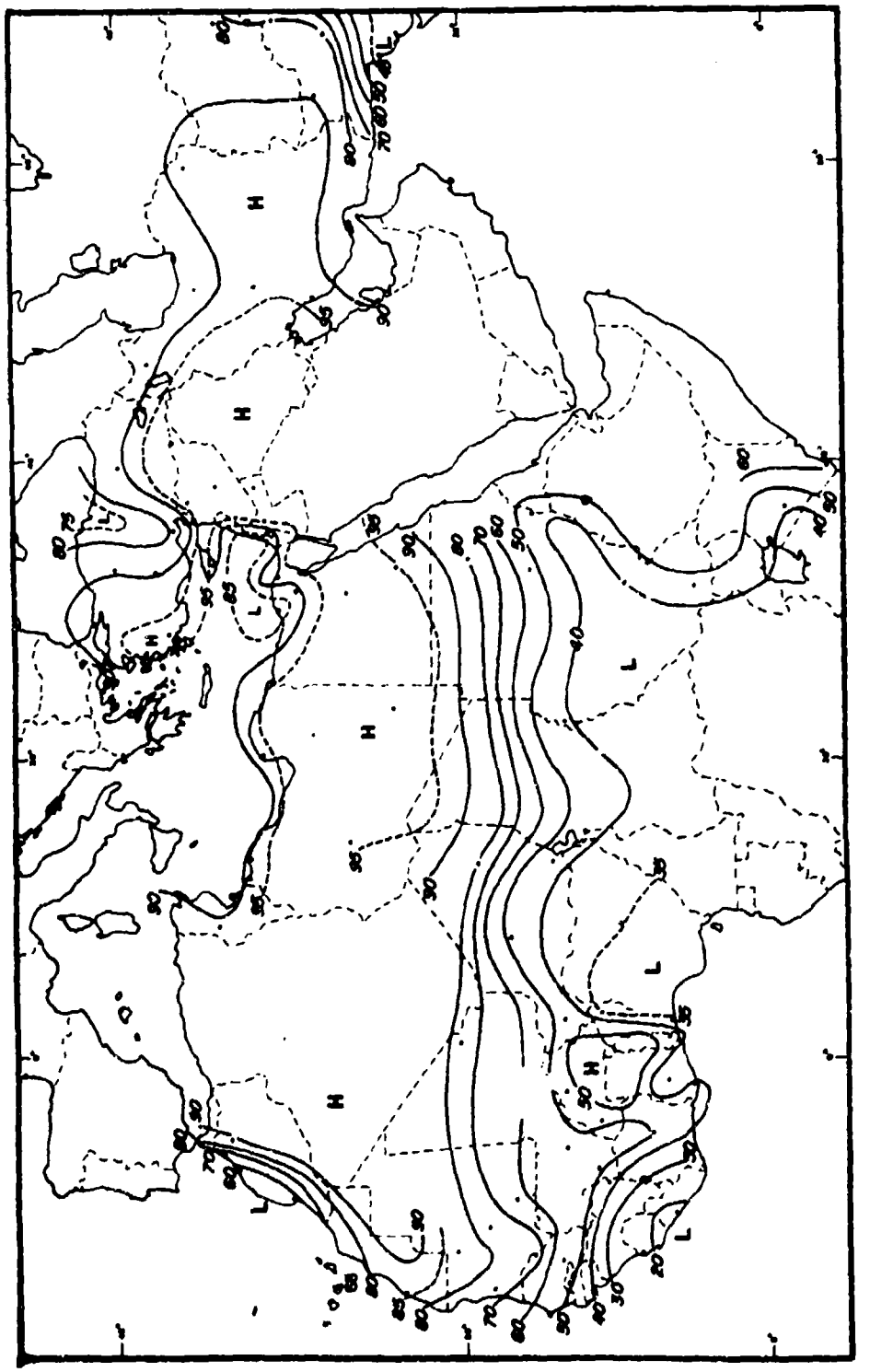

Figure 27. CFLOS Probabilities for July, 0000-0200 LST, 30° Elevation

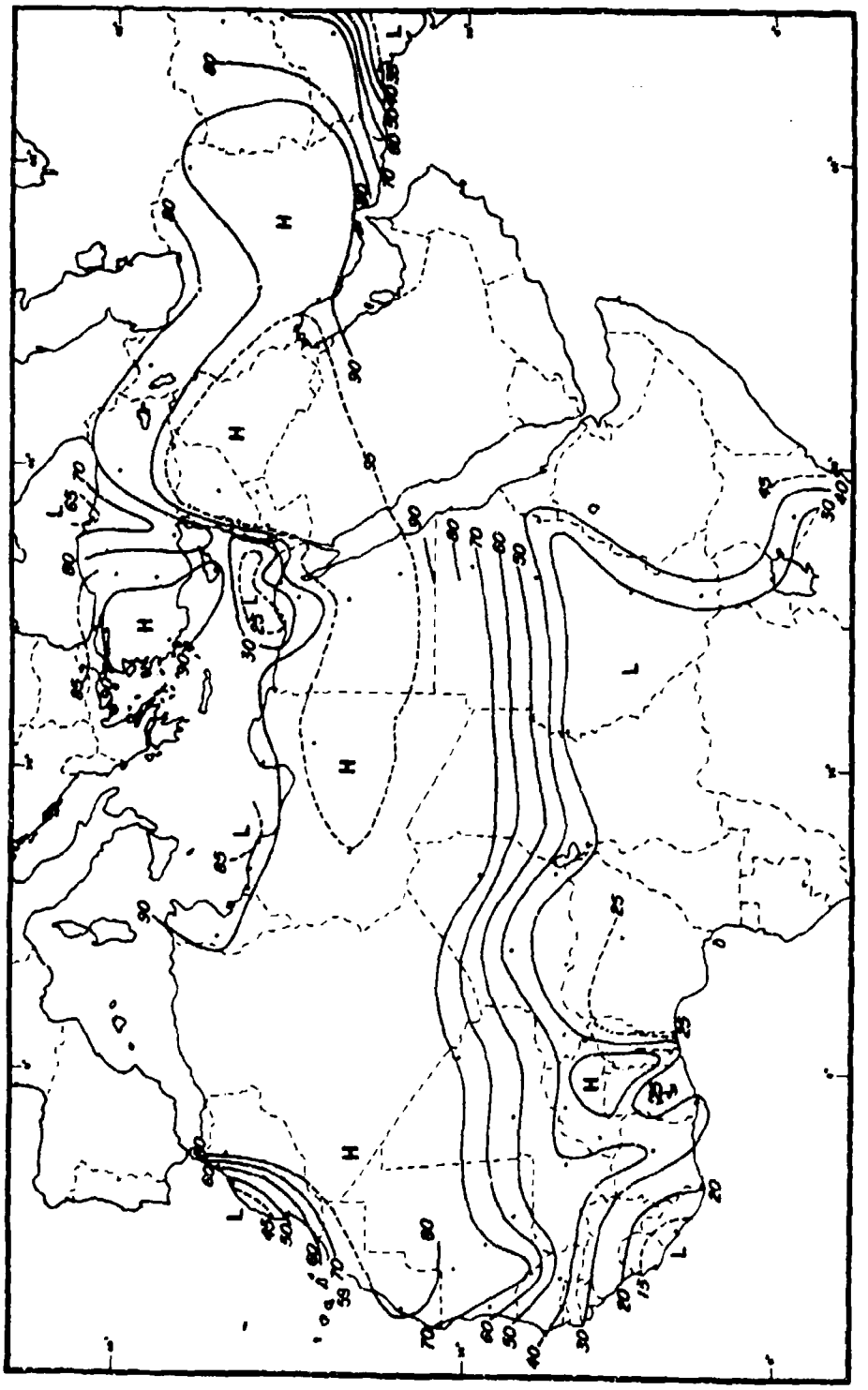

Figure 28. CFLOS Probabilities for July, 0000-0200 LST, 10° Elevation

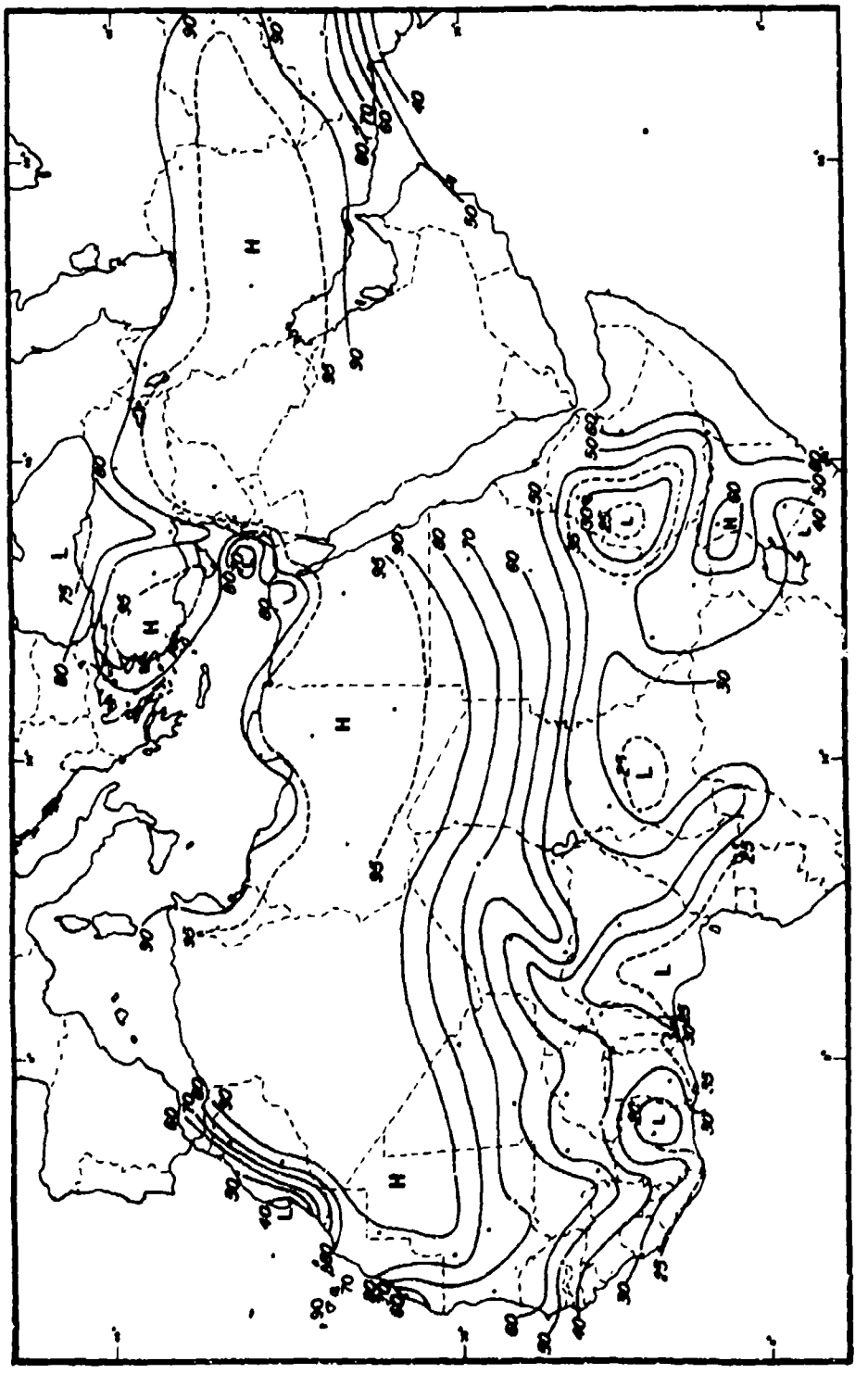

Figure 29. CFLOS Probabilities for July, 0600-0800 LST, 90° Elevation

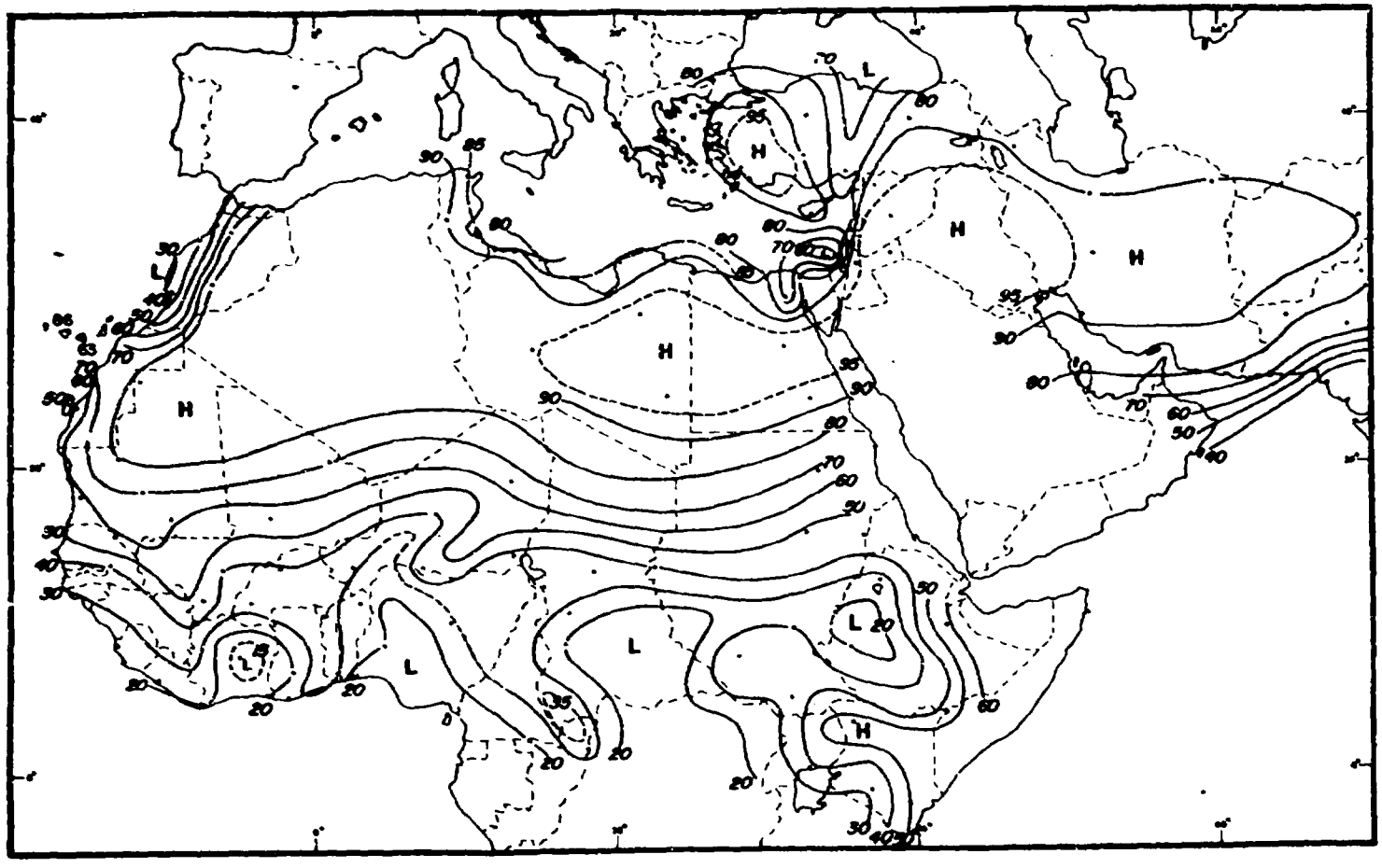

Figure 30. CFLOS Probabilities for July, 0600-0800 LST, 30° Elevation

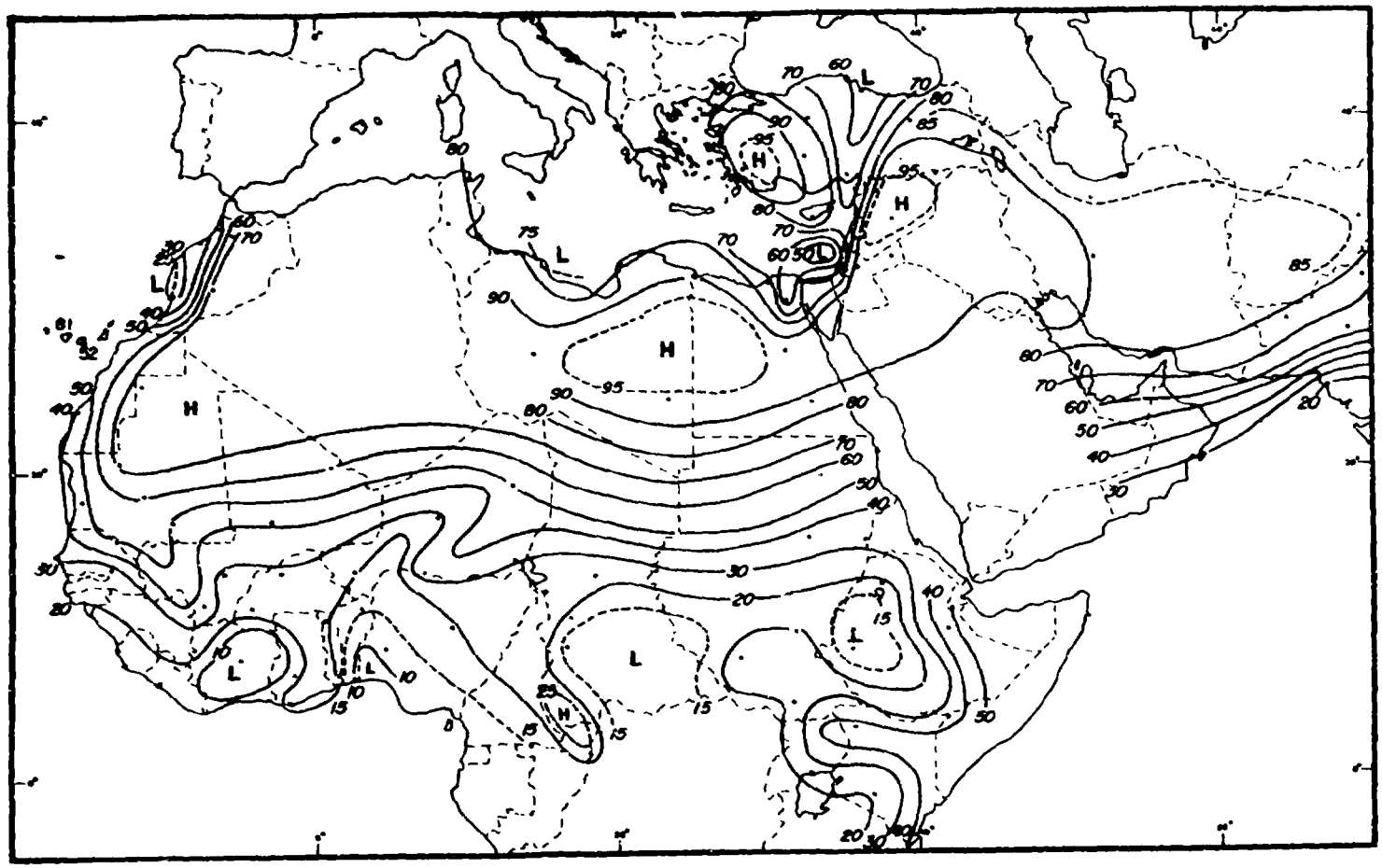

Figure 31. CFLOS Probabilities for July, 0600-0800 LST, 10° Elevation

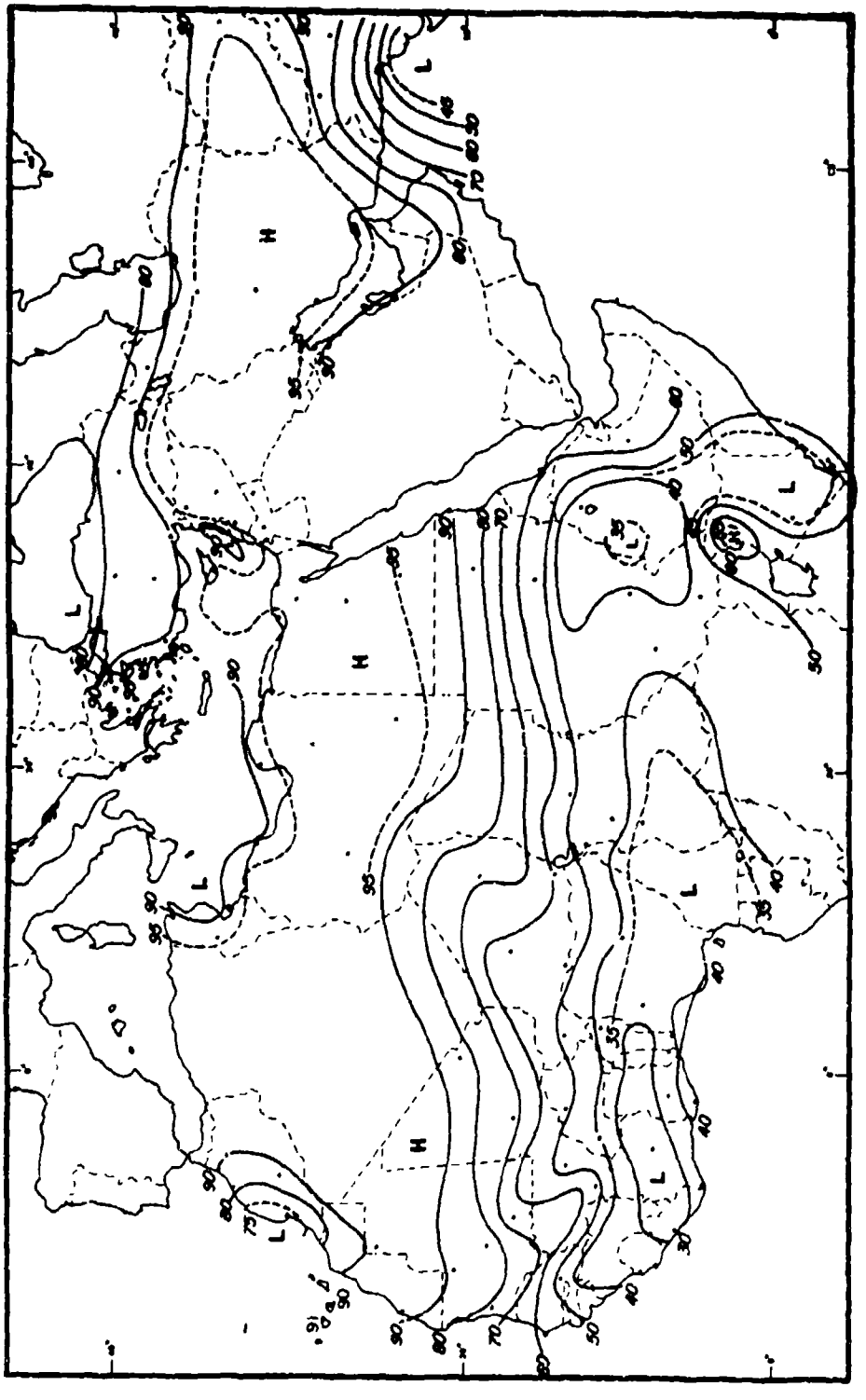

Figure 32. CFLOS Probabilities for July, 1200-1400 LST, 90° Elevation

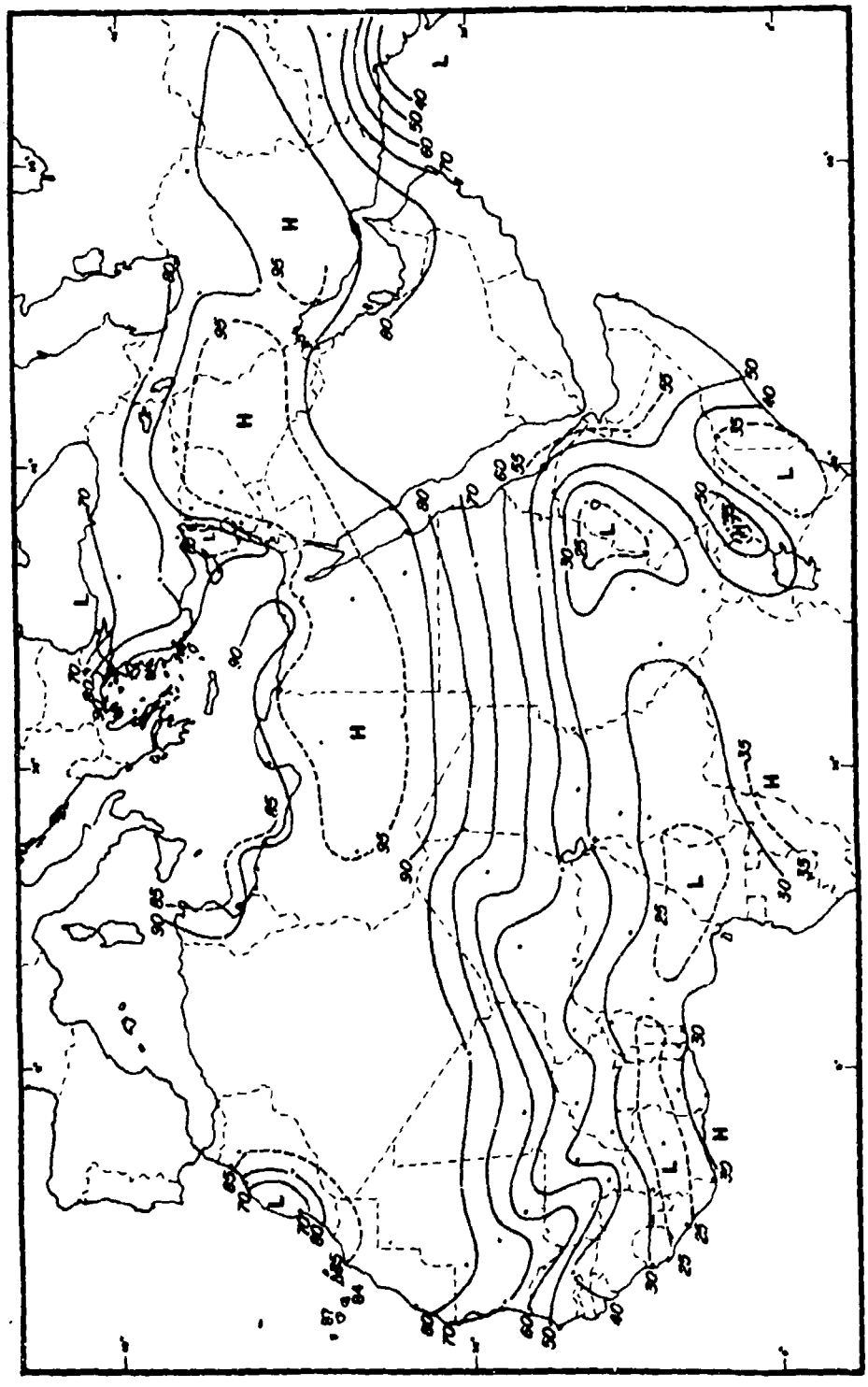

Figure 33. CFLOS Probabilities for July, 1200-1400 LST, 30° Elevation

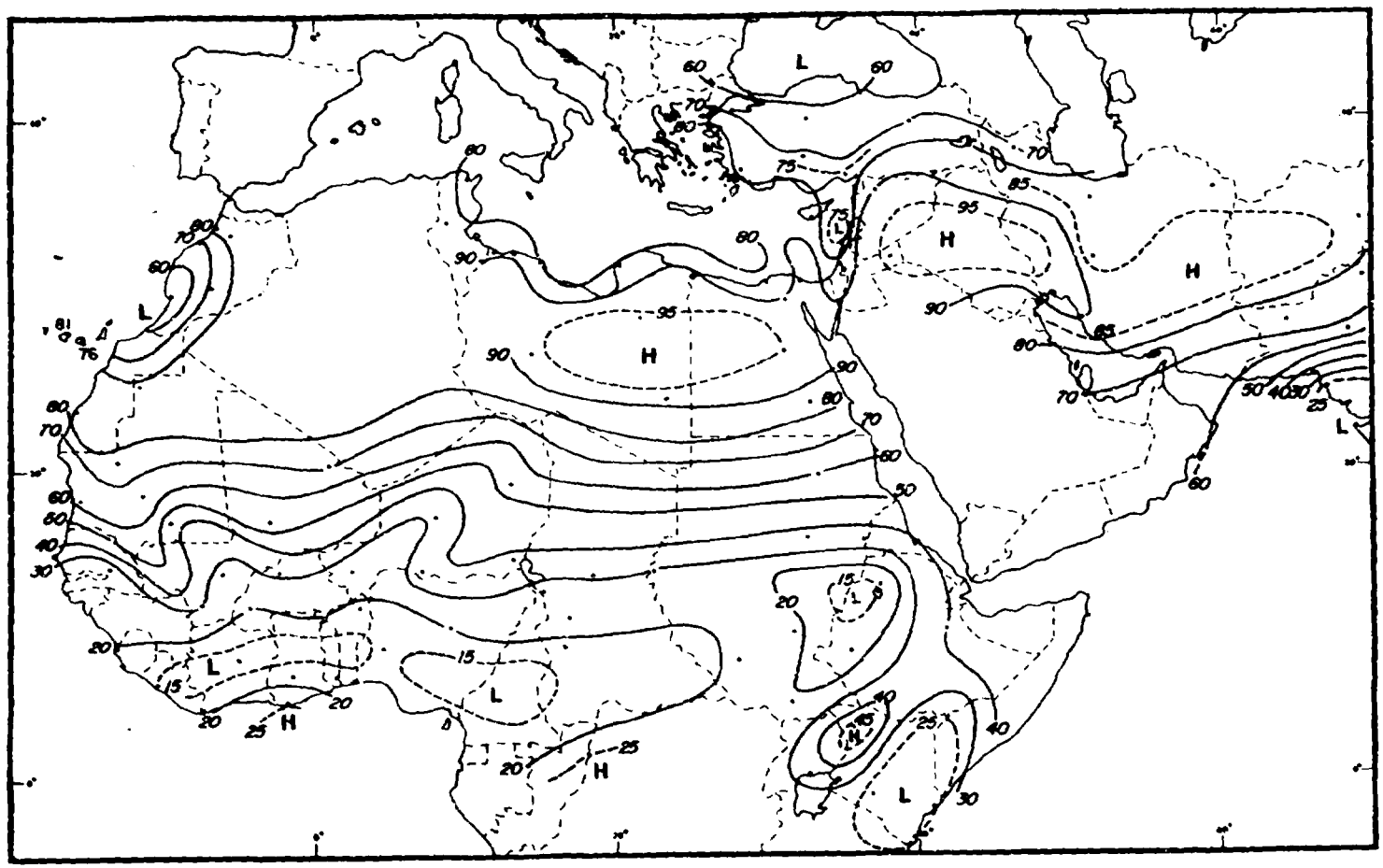

Figure 34. CFLOS Probabilities for July, 1200-1400 LST, 10° Elevation

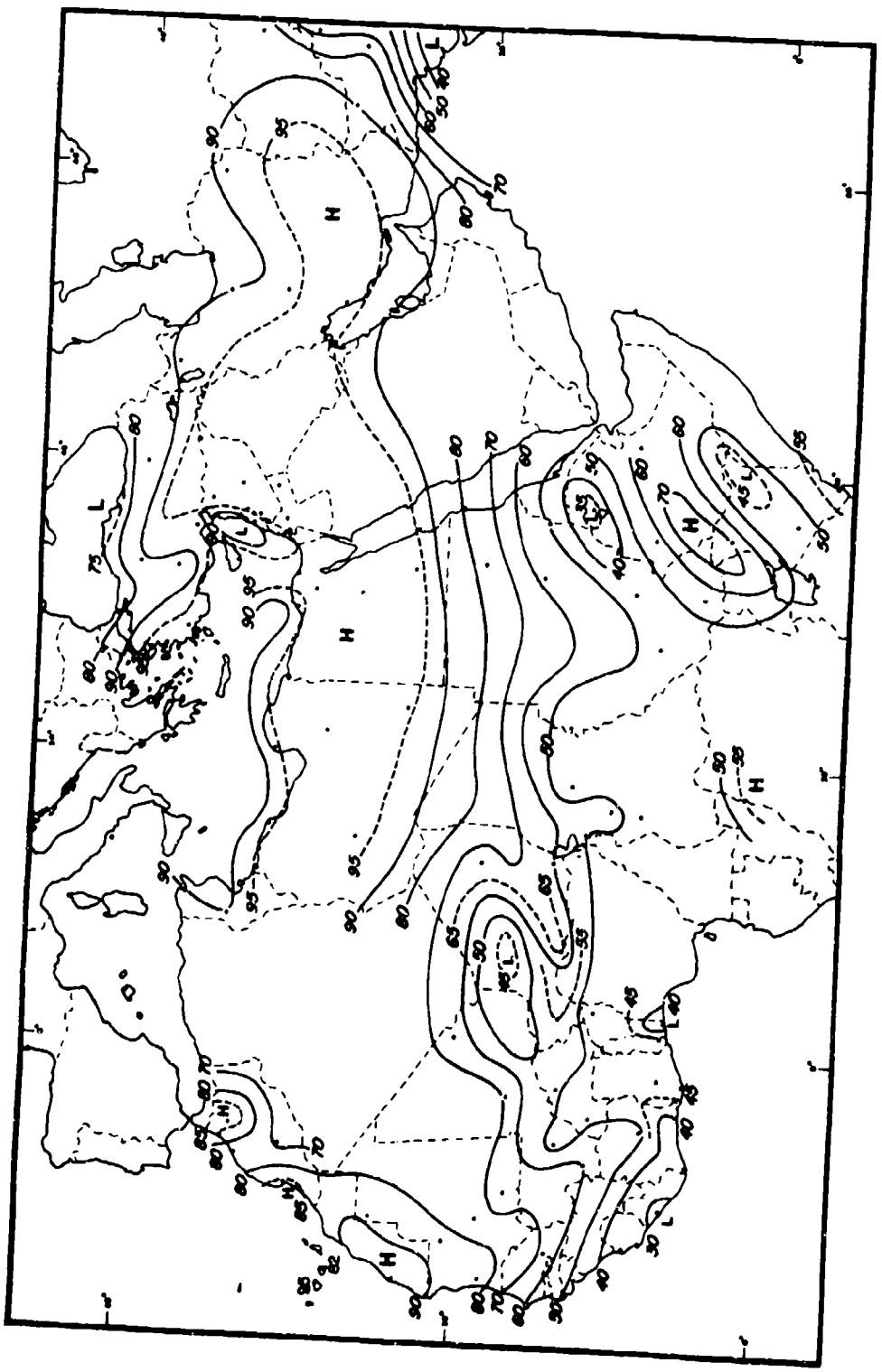

Figure 35. CFLOS Probabilities for July, 1800-2000 LST, 90° Elevation

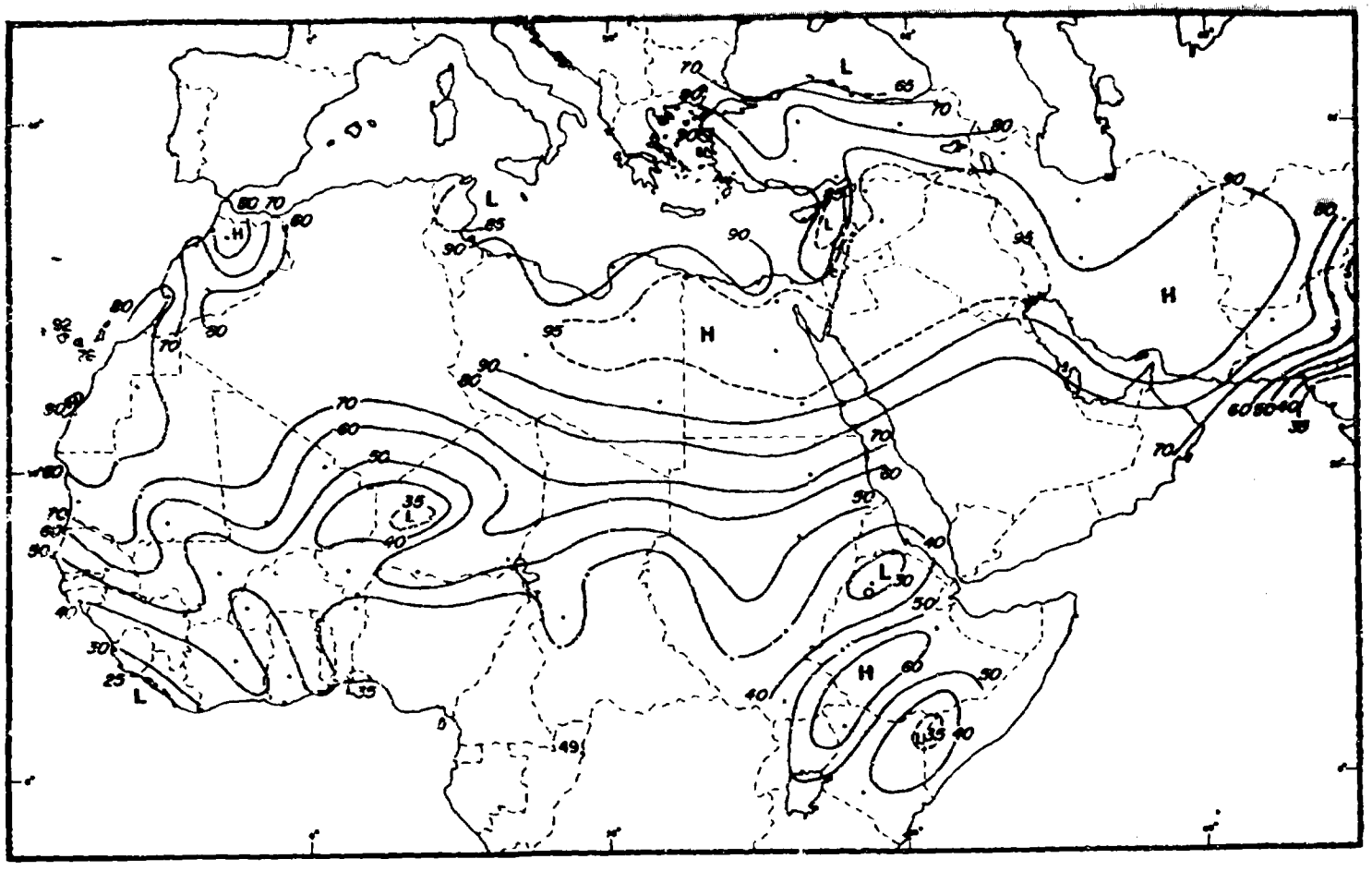

Figure 36. CFLOS Probabilities for July, 1800-2000 LST, 30° Elevation

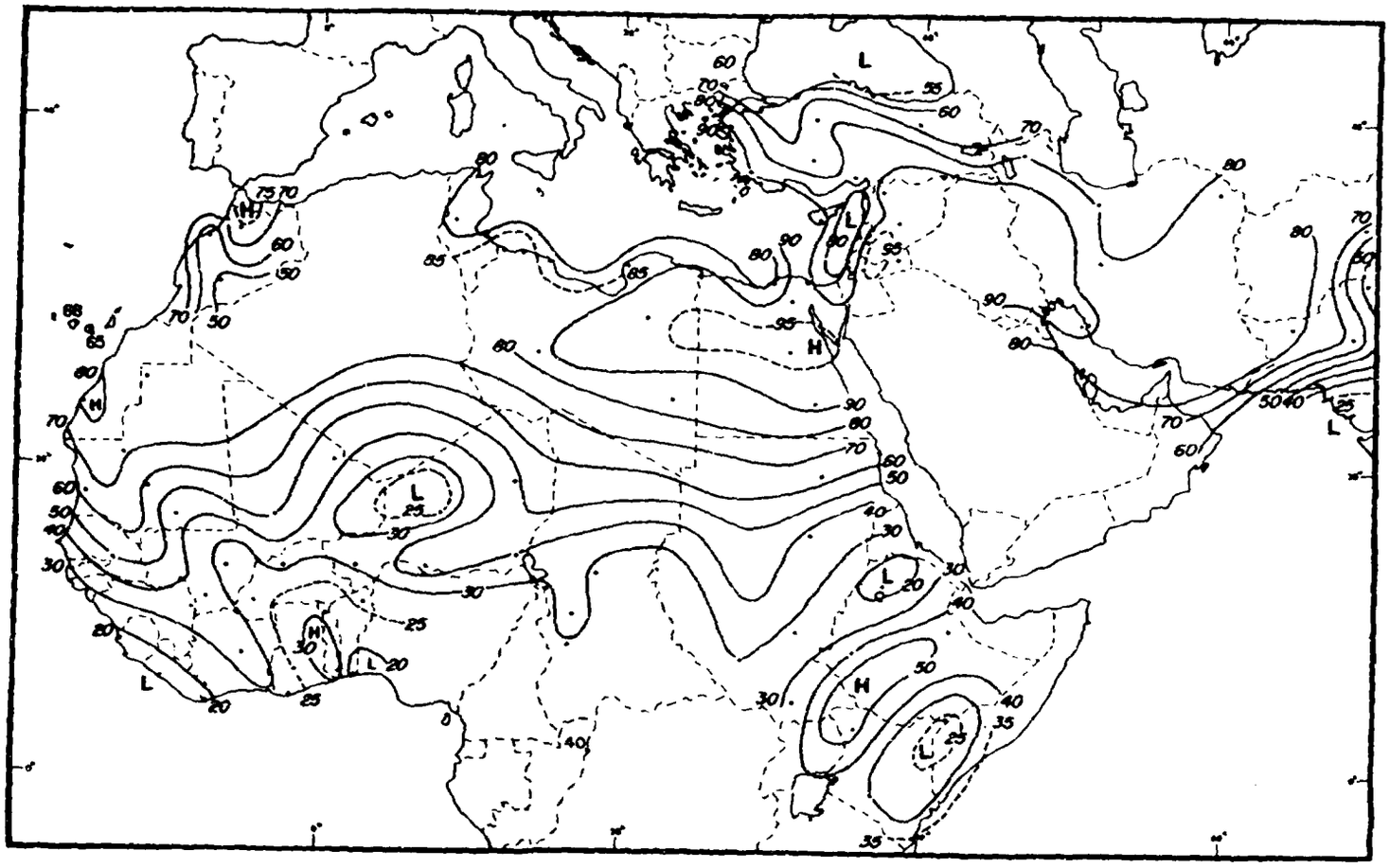

Figure 37. CFLOS Probabilities for July, 1800-2000 LST, 10° Elevation

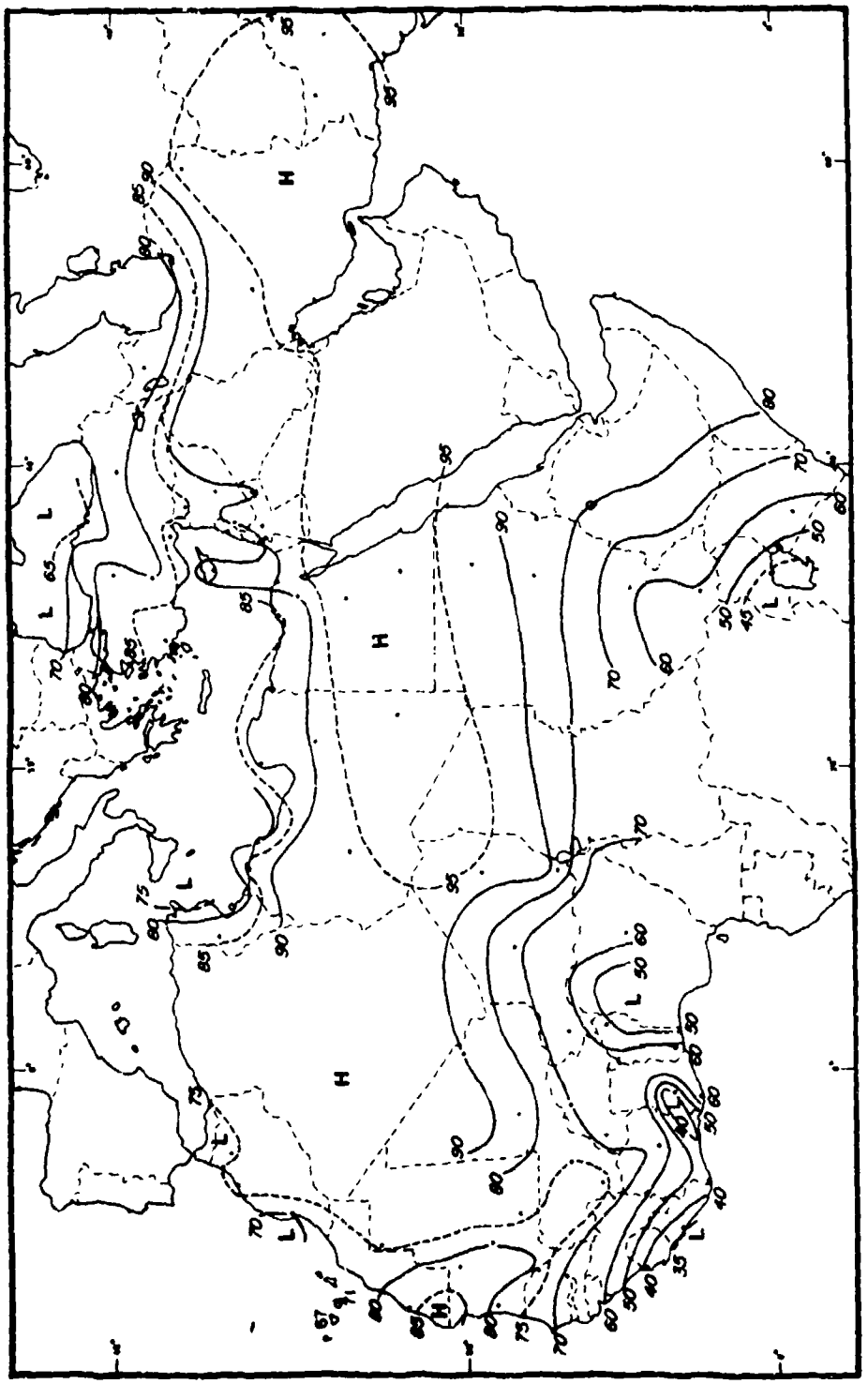

Figure 38. CFLOS Probabilities for Oct, 0000-0200 LST, 90° Elevation

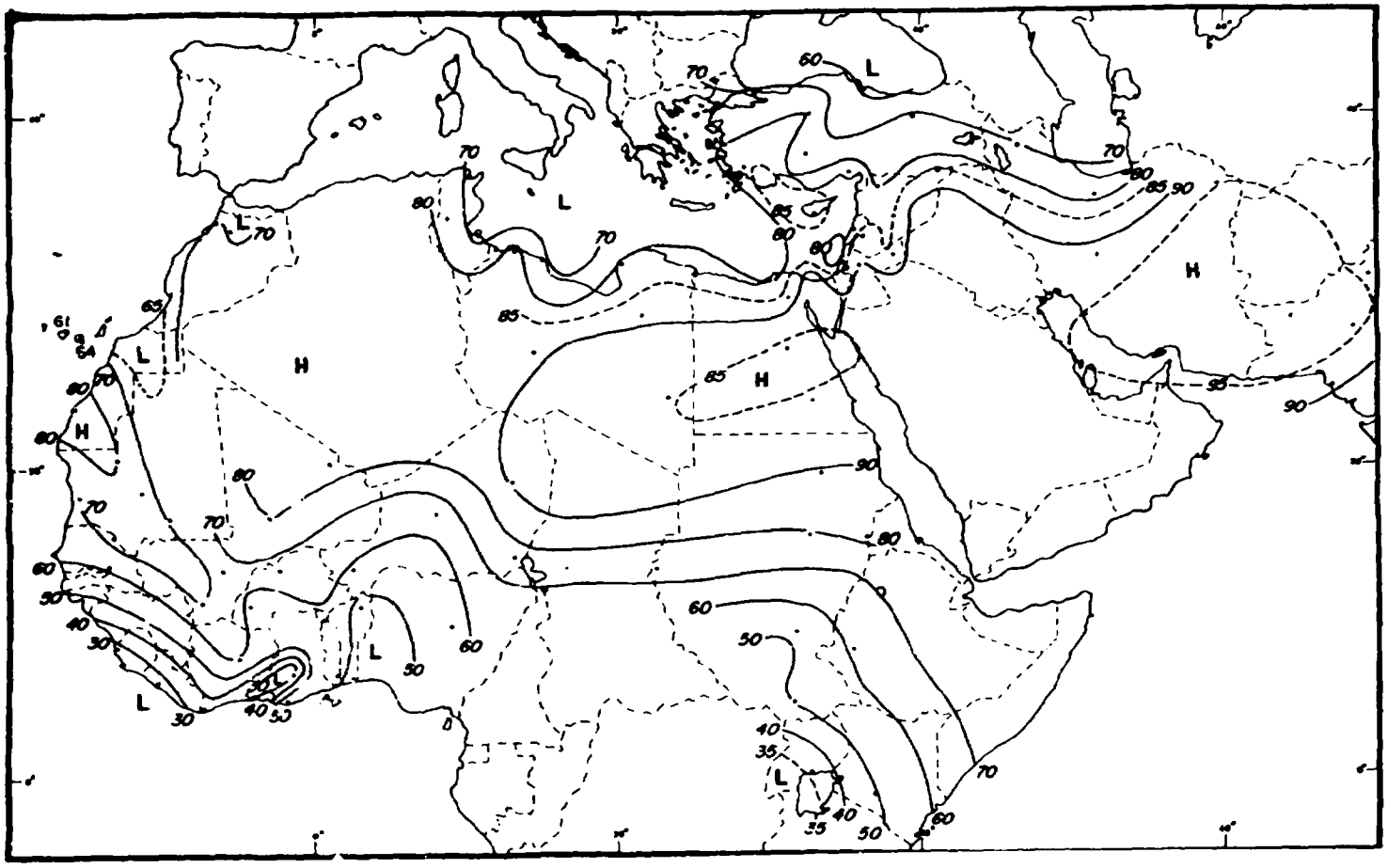

Figure 39. CFLOS Probabilities for Oct, 0000-0200 LST, 30° Elevation

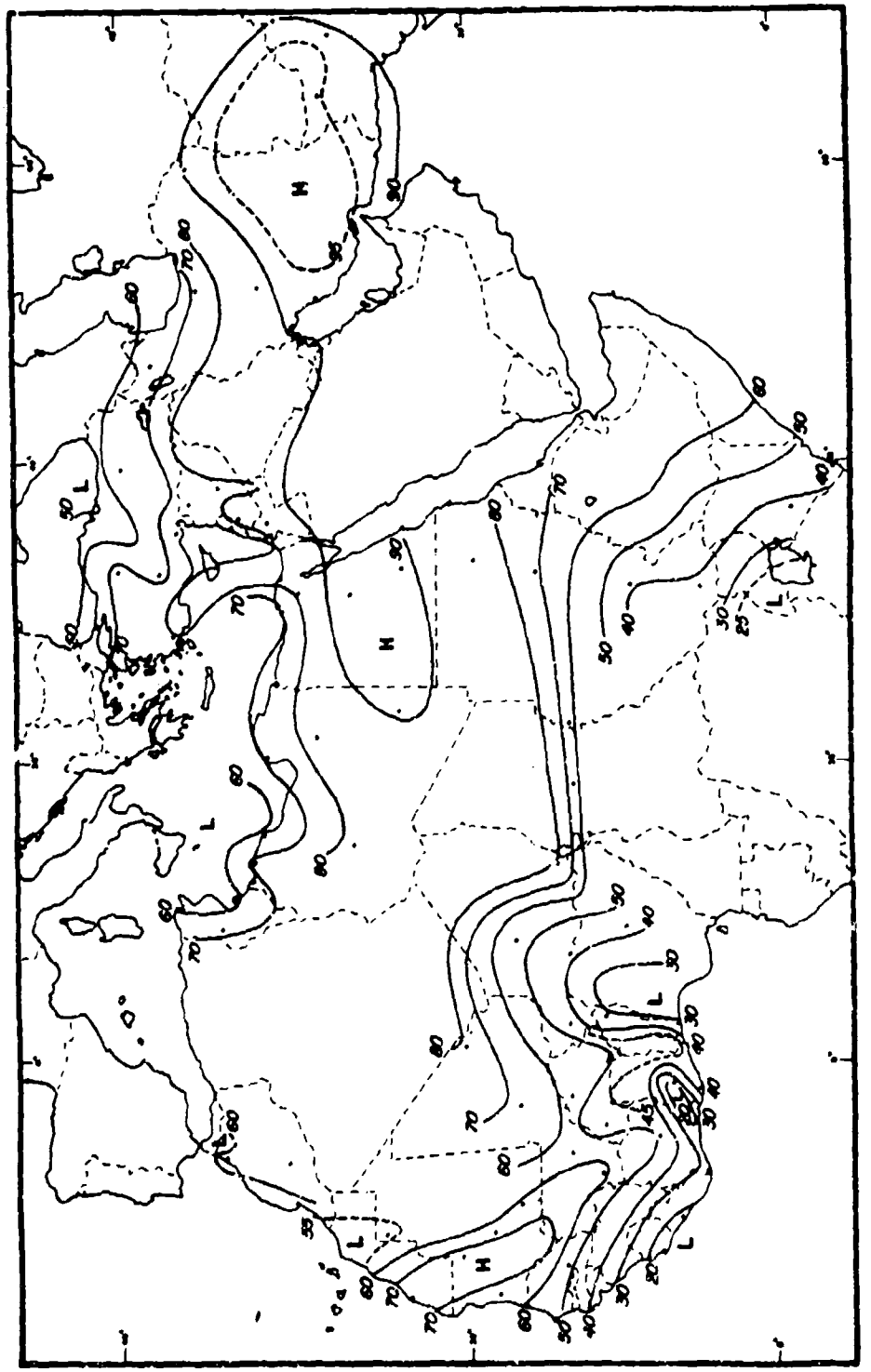

Figure 40. CFLOS Probabilities for Oct, 0000-0200 LST, 10° Elevation

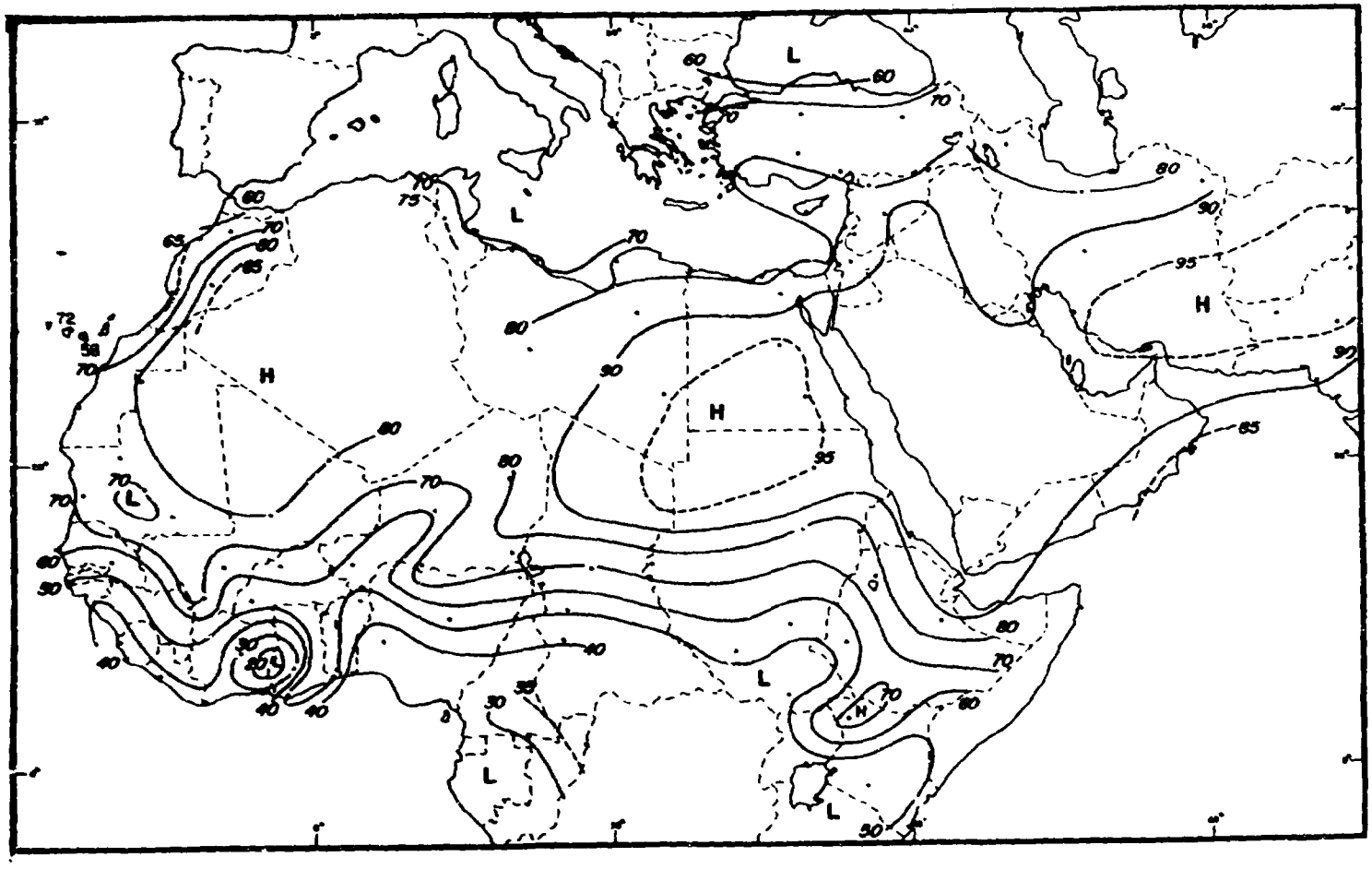

Figure 41. CFLOS Probabilities for Oct, 0600-0800 LST, 90° Elevation

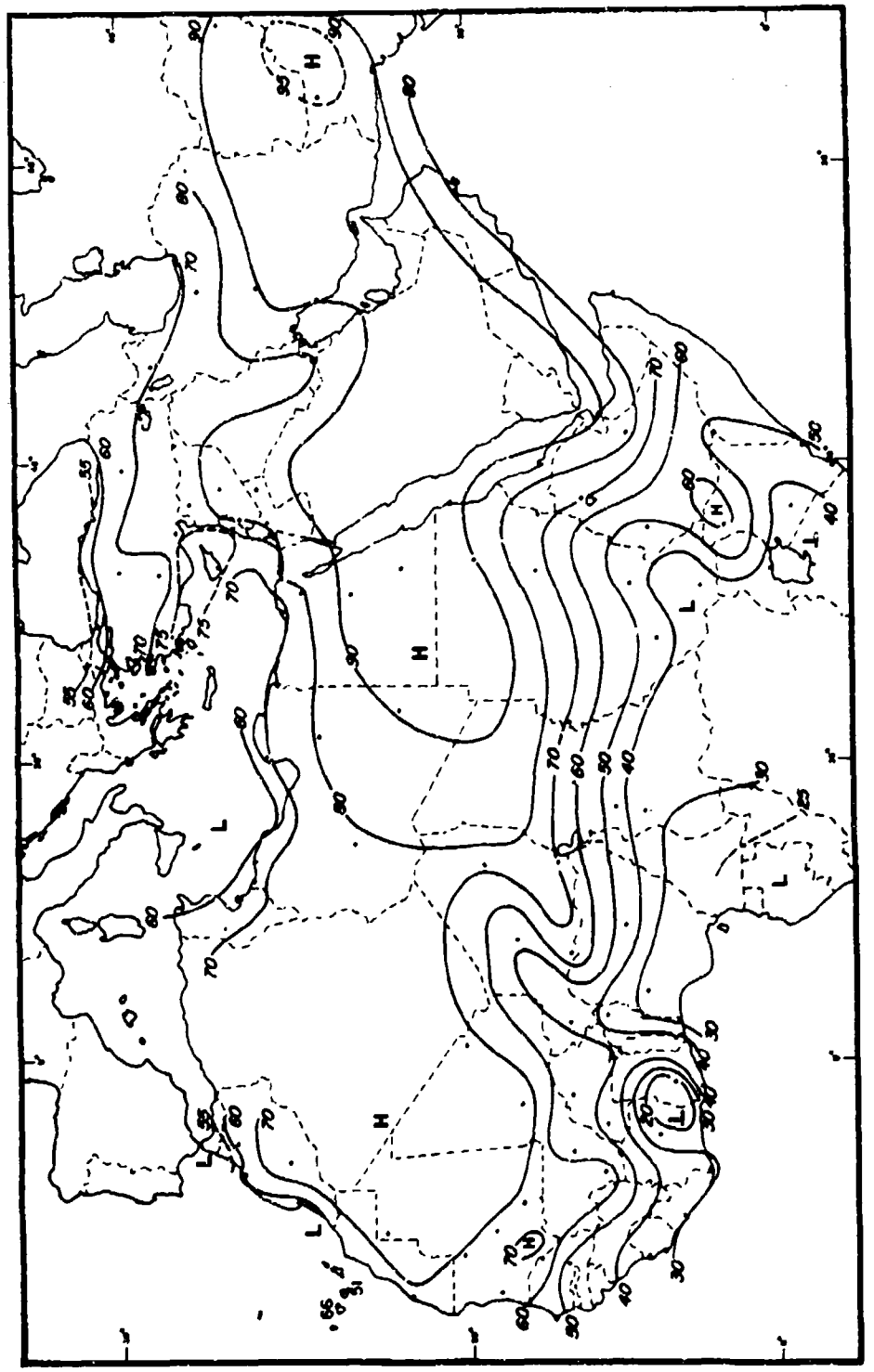

Figure 42. CFLOS Probabilities for Oct. 0600-0800 LST, 30° Elevation

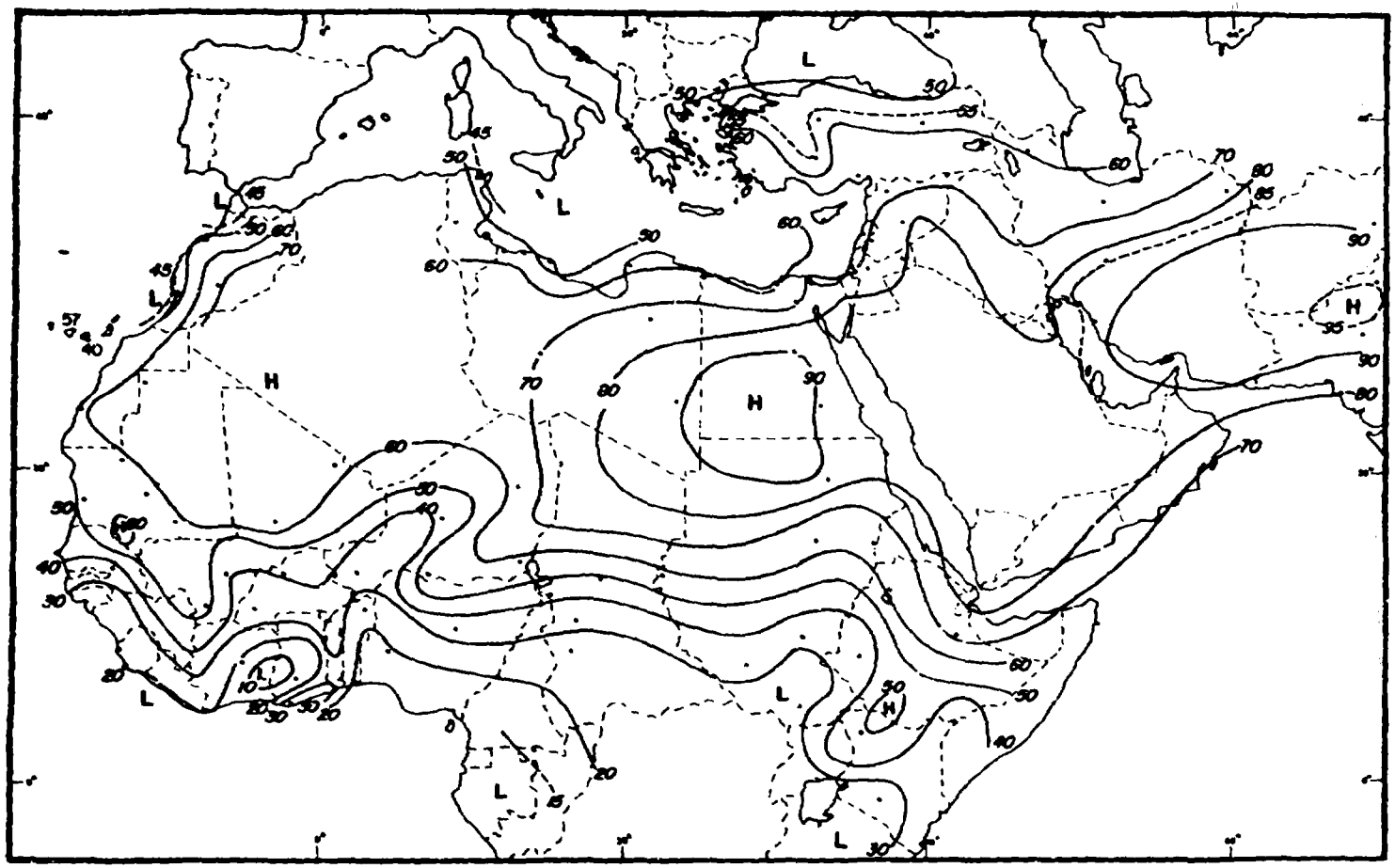

Figure 43. CFLOS Probabilities for Oct, 0600-0800 LST, 10° Elevation

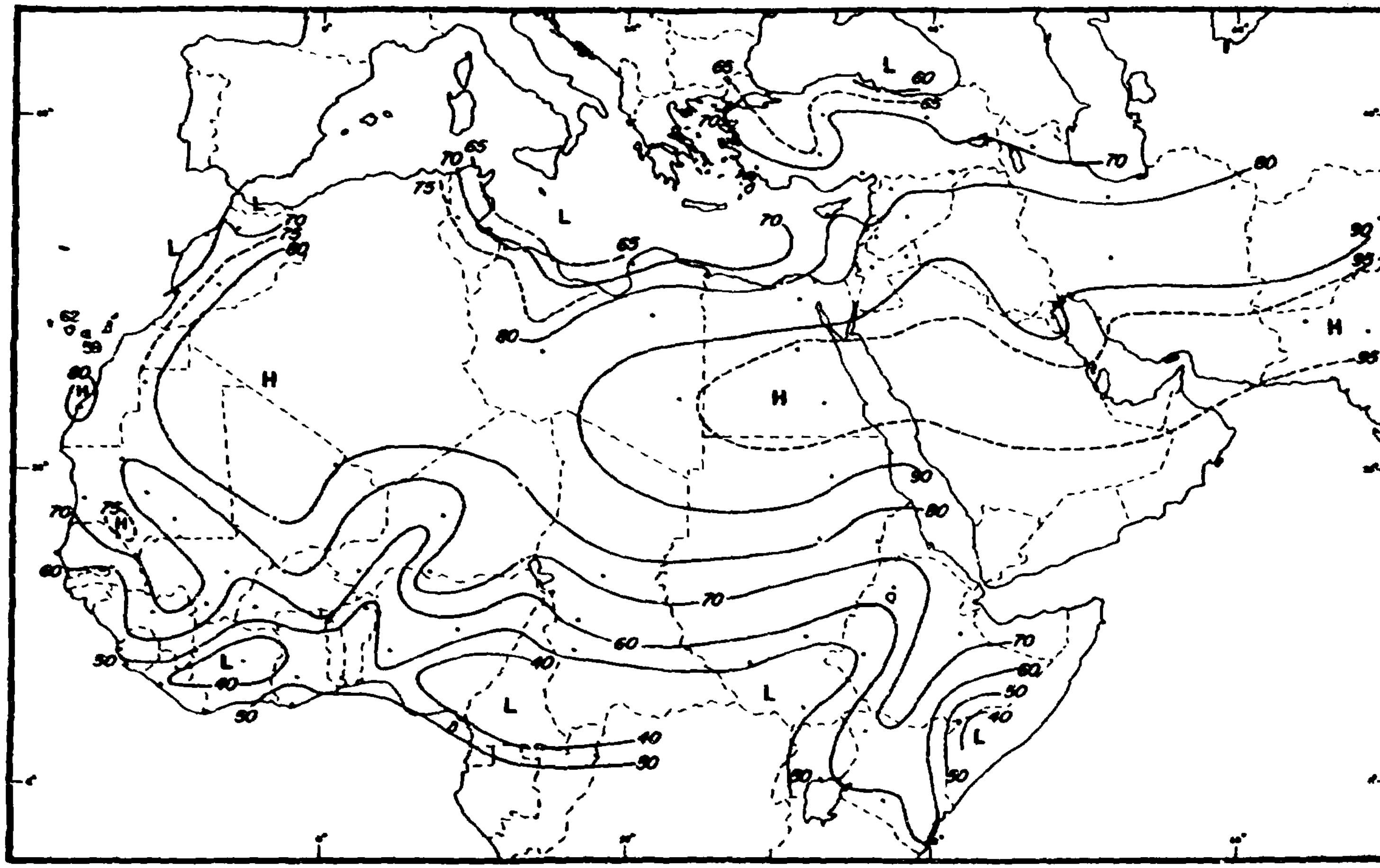

Figure 44. CFLOS Probabilities for Oct, 1200-1400 LST, 90° Elevation

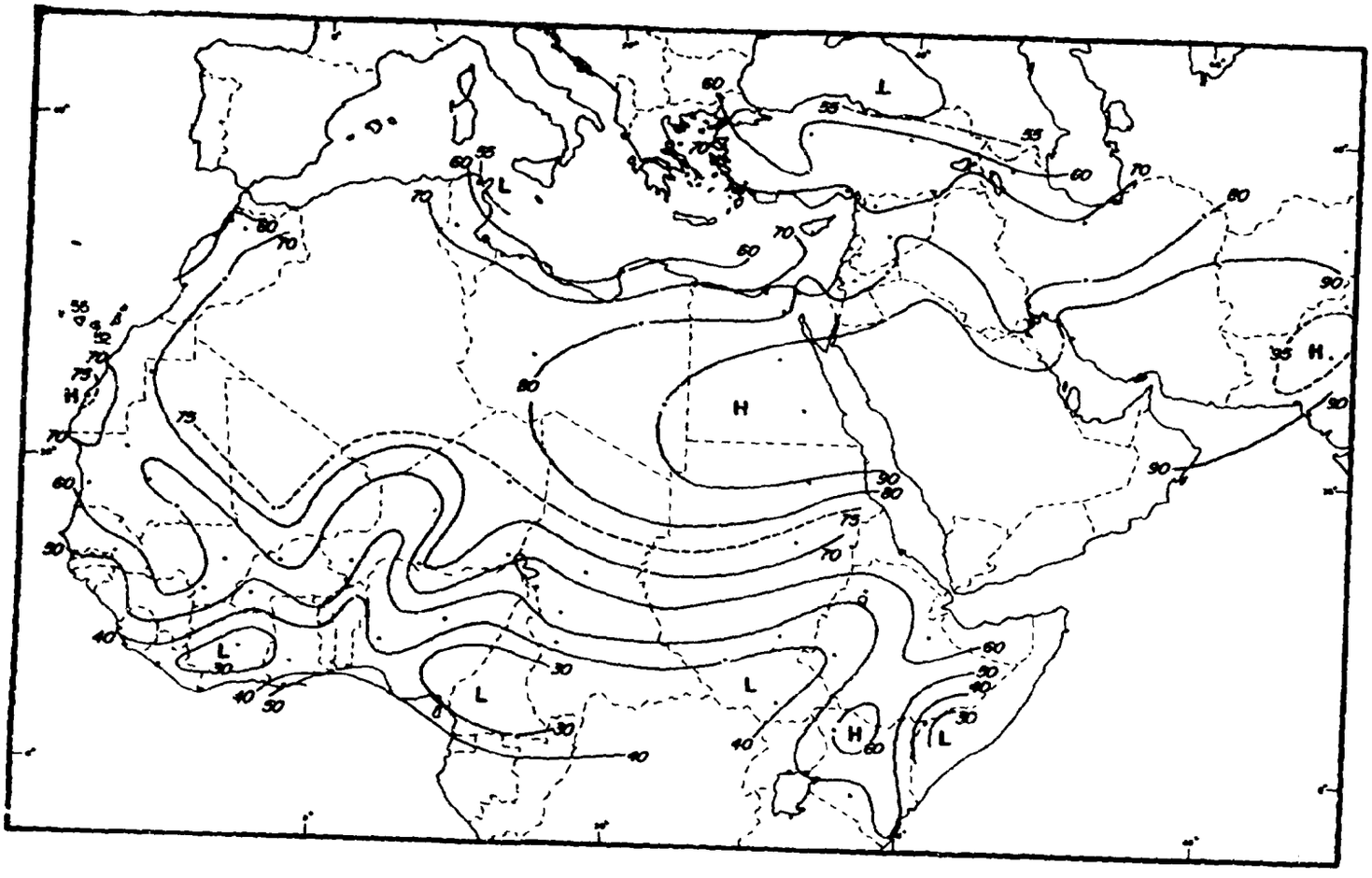

Figure 45. CFLOS Probabilities for Oct, 1200-1400 LST, 30° Elevation

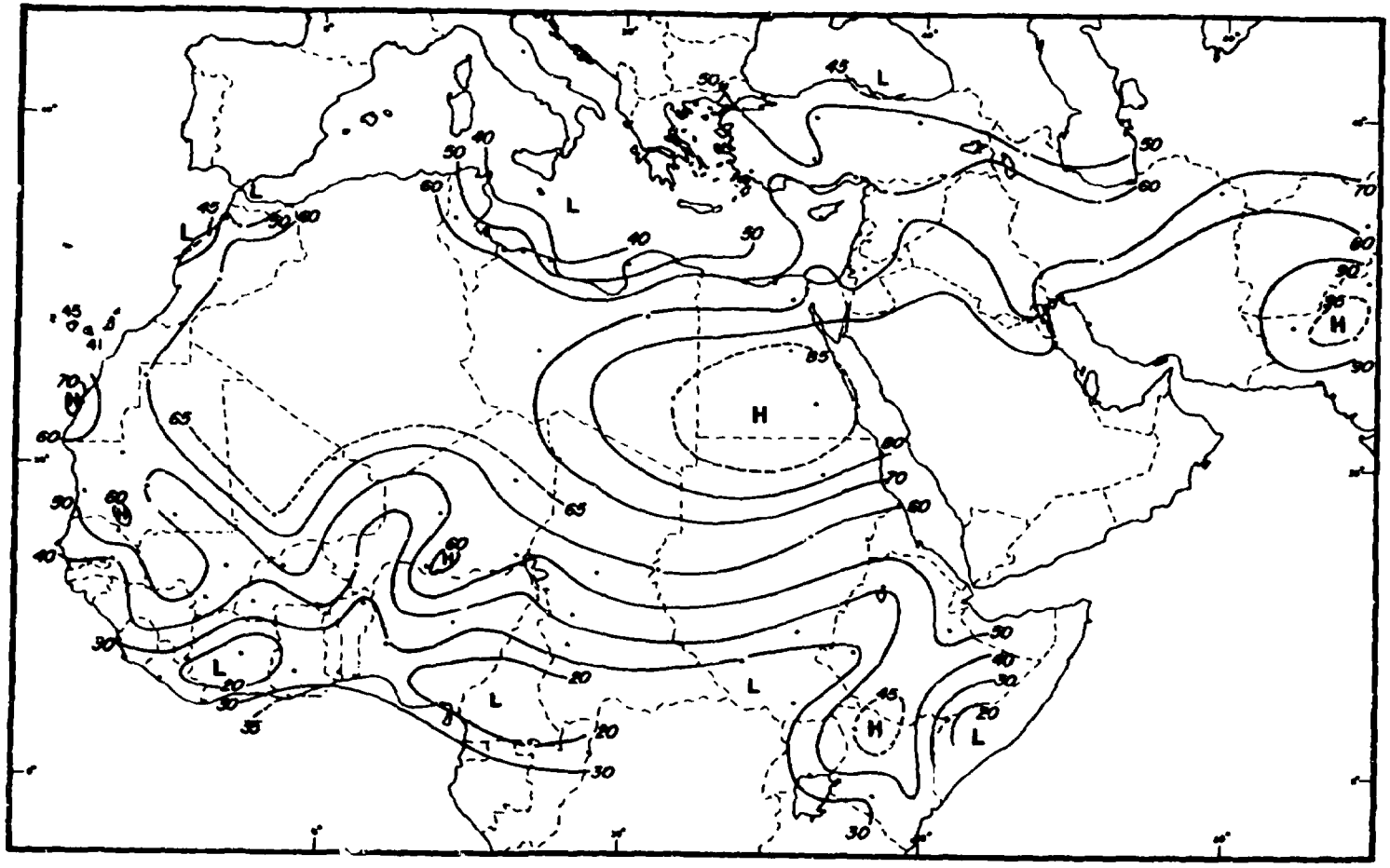

Figure 46. CFLOS Probabilities for Oct, 1200-1400 LST, 10° Elevation

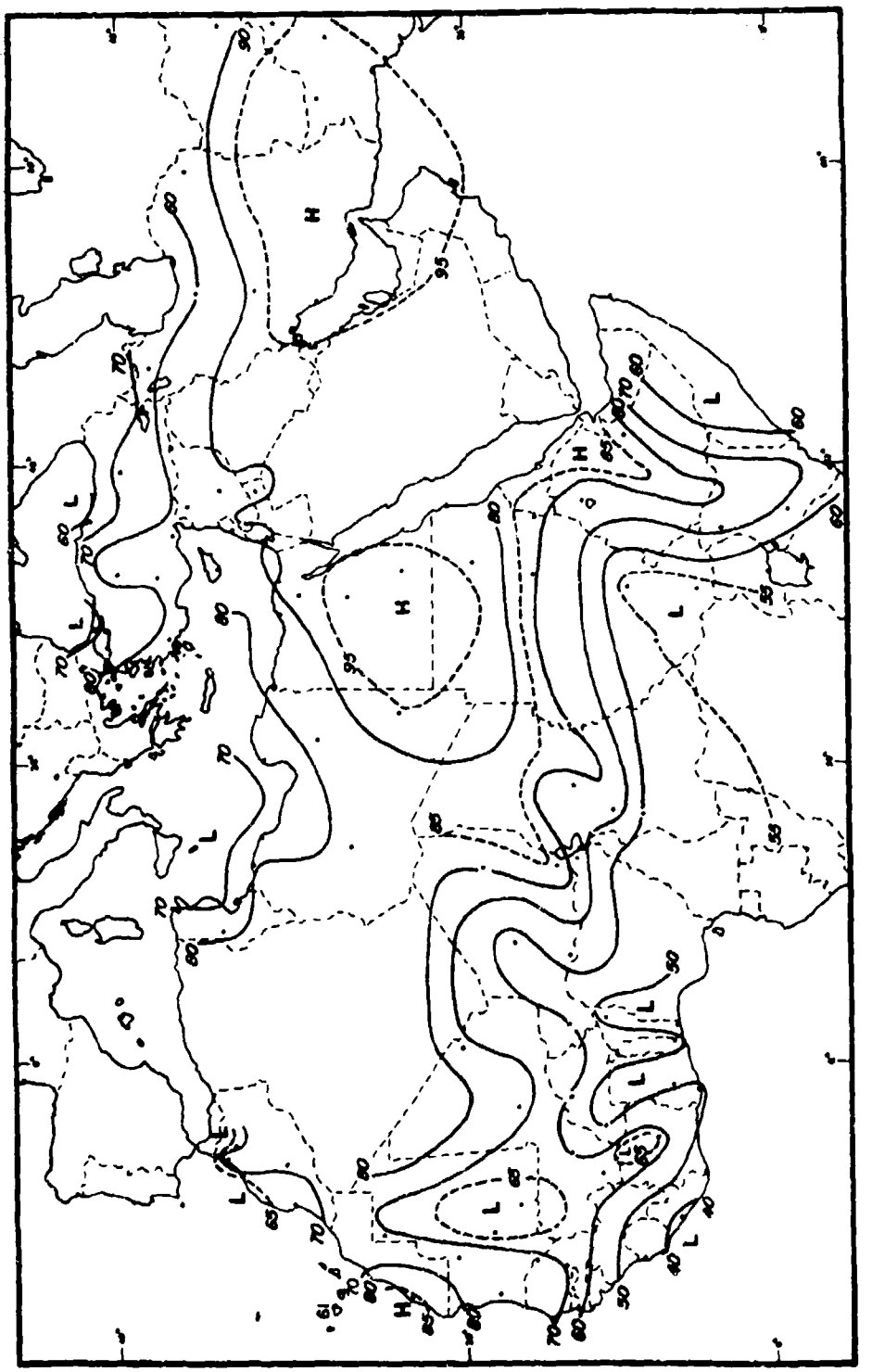

Figure 47. CFLOS Probabilities for Oct, 1800-2000 LST, 90° Elevation

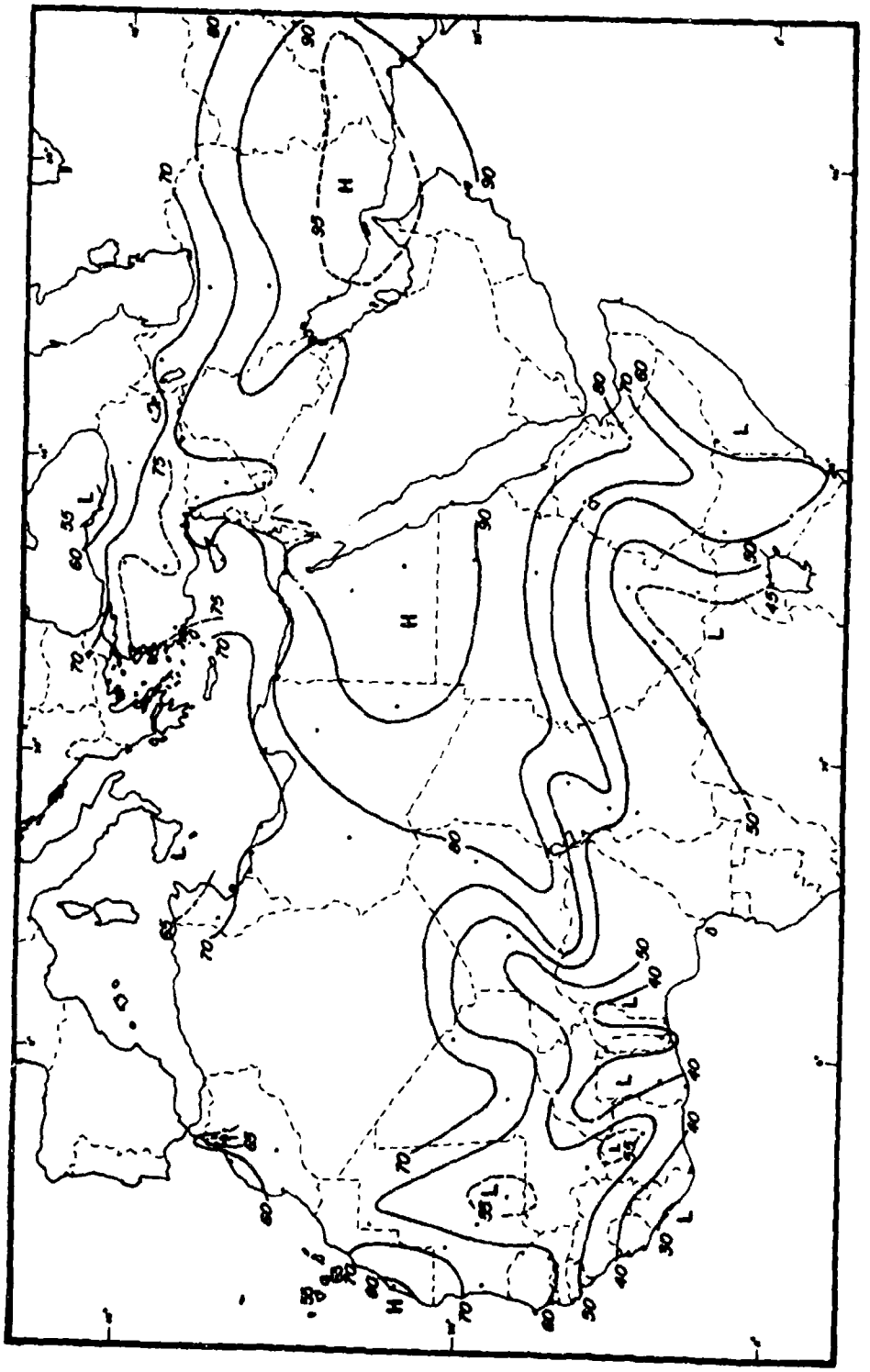

Figure 48. CFLOS Probabilities for Oct, 1800-2000 LST, 30° Elevation

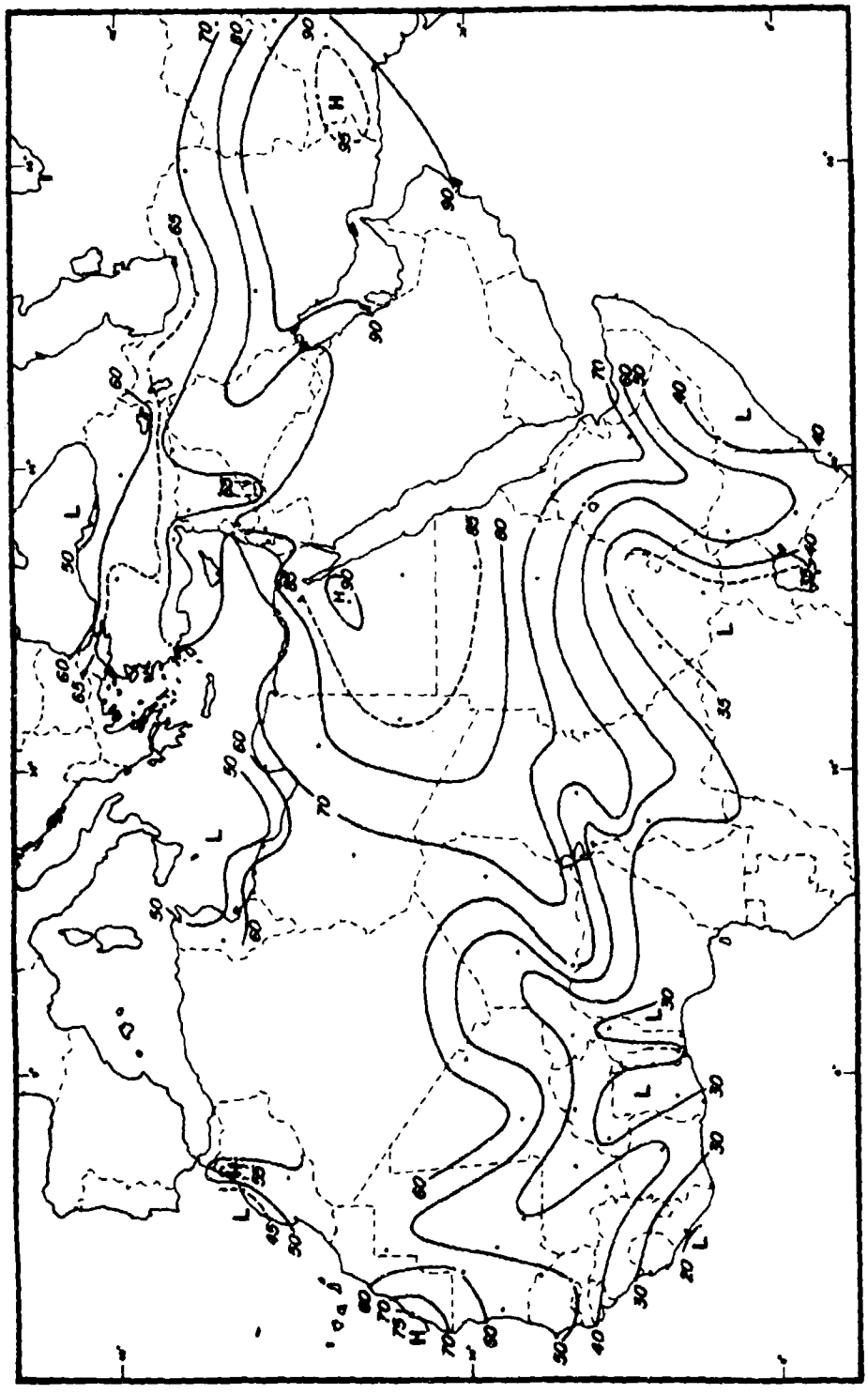

Figure 49. CFLOS Probabilities for Oct, 1800-2000 LST, 10° Elevation

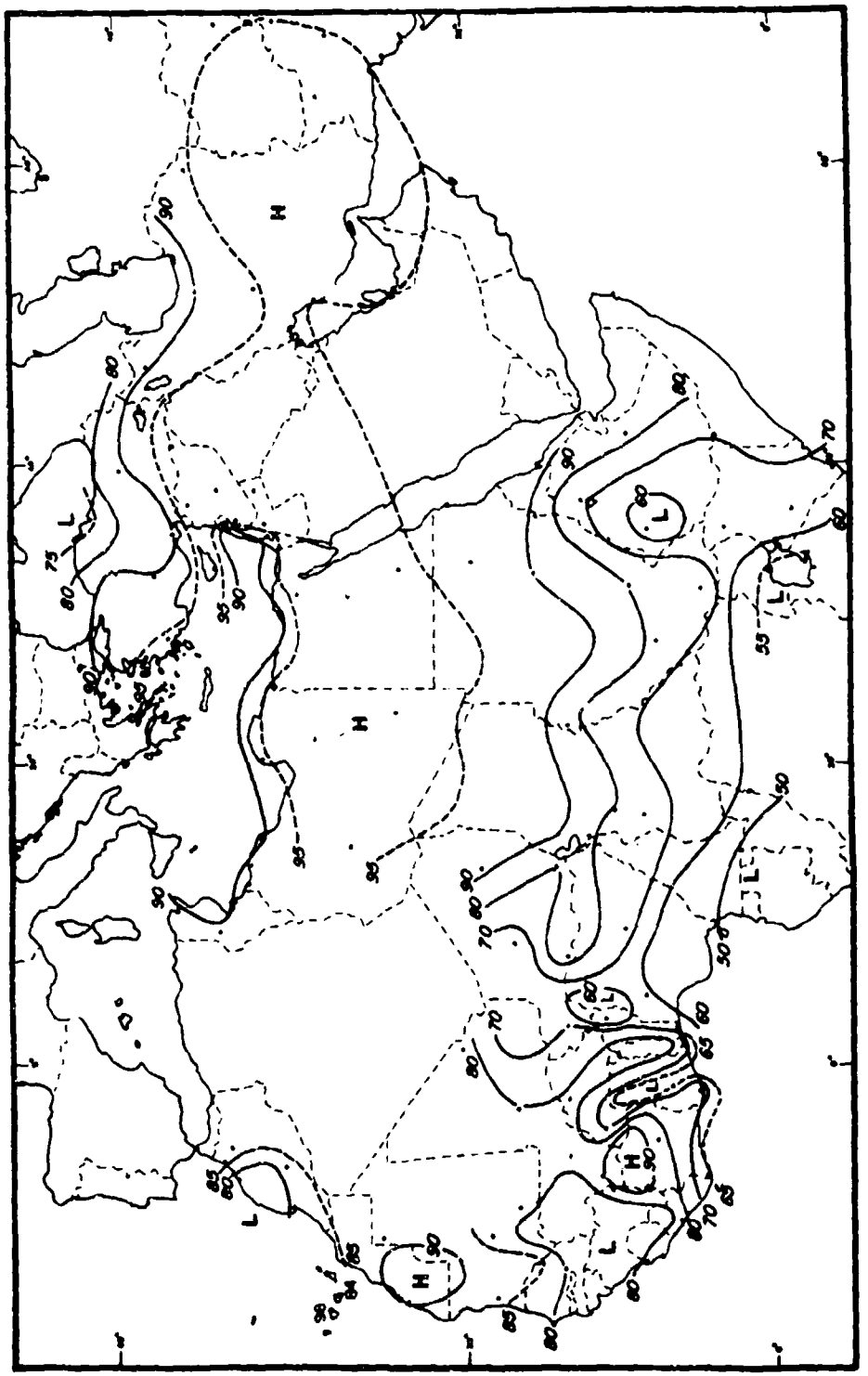

Figure 50. Highest CFLOS Probability, 30° Elevation

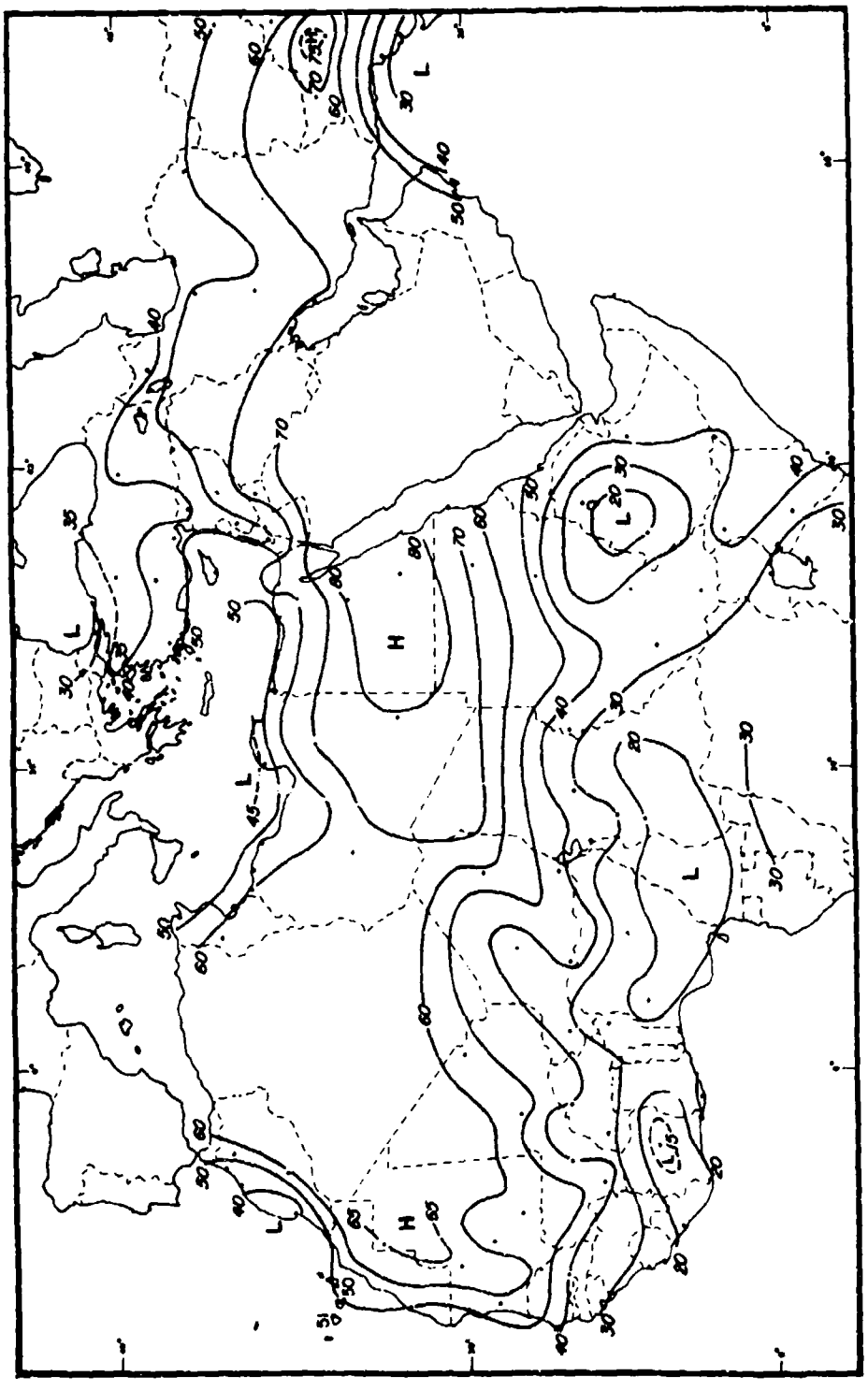

Figure 51. Lowest CFLOS Probability, 30° Elevation

References

1. Lund, I. A., Grantham, D. D., and Elam, C. B., Jr. (1975) Atlas of Cloud-Free Line-of-Sight Probabilities, Part 1: Germany, AF Surveys in Geophysics No. 309, AFCRL-TR-75-0261, 77 pp.

2. Lund, I. A., Grantham, D. D., and Elam, C. B., Jr. (1976) Atlas of Cloud-Free Line-of-Sight Probabilities, Part 2: Union of Soviet Socialist Republics, AF Surveys in Geophysics No. 358, AFGL-TR-77-0005, 63 pp.

3. Lund, I. A., Grantham, D. D., and Elam, C. B., Jr. (1977) Atlas of Cloud-Free Line-of-Sight Probabilities, Part 3: United States of America, AF Surveys in Geophysics No. 374, AFGL-TR-77-0188, 73 pp.

4. Lund, I. A., Grantham, D. D., and Elam, C. B., Jr. (1978) Atlas of Cloud-Free Line-of-Sight Probabilities, Part 4: Europe, AF Surveys in Geophysics No. 400, AFGL-TR-78-0276, 71 pp.

5. Lund, I. A., and Shanklin, M. D. (1973) Universal methods for estimating probabilities of cloud-free lines-of-sight through the atmosphere, J. Appl. Meteorol. 12 (No. 1):28-35.